DOCUMENT RESUME

ED 174 483 SE 028 619

AUTHOR Mills, Stephen R.; And Others
TITLE Optimal Use of Finite Land Resources. Field Test Version.
INSTITUTION Far West Lab. for Educational Research and Development, San Francisco, Calif.
SPONS AGENCY Office of Education (DHEW), Washington, D.C. Office of Environmental Education.
PUB DATE 77
GRANT G007701993
NOTE 339p.; For related documents, see SE 028 618-625; Not available in hard copy due to marginal legibility of original document; Page 265 deleted due to poor reproducibility of original

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Energy; Environment; *Environmental Education; *Land Use; *Natural Resources; *Public Policy; *Regional Planning; Resource Materials; Secondary Education; *Teacher Education
IDENTIFIERS Energy Education

ABSTRACT

This module, a component of a larger teaching model, seeks to present several concepts to the teacher. It seeks to develop awareness and understanding of use of finite land resources including types of land use and abuse; stewardship of land resources; natural systems functioning; human system demands on the natural environment; carrying capacity; and planning for land use. It further seeks to facilitate teacher development of classroom materials focused on the problem or issue of land use. (Author/RE)

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OPTIMAL USE OF FINITE LAND RESOURCES

FAR WEST LABORATORY
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SE 028 619

OPTIMAL USE OF FINITE LAND RESOURCES

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Grant No. G007701993

The activity which is the subject of this report was supported in whole or in part, by the United Stated Office of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the United States Office of Education, the Department of Health, Education, and Welfare, or the Far West Laboratory for Educational Research and Development, and no official endorsement by these agencies should be inferred.

ACKNOWLEDGEMENTS

Far West Laboratory gratefully acknowledges the contributions of the following persons:

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Our Teacher Contributors: Carol Horan, Educational Consultant, Marin County Schools; Judy Voets, Toni Miller, Sally Hornick, Nelson Lecklikner, Judith Colton, Nancy Osborne, Bernard Keener, Joe Gravina

Our Module Review Panel: Ralph Bohn (San Jose State University); Esther Railton (California State University at Hayward); Don Langan (Kalispell Public Schools, Montana); Louis Rubin (University of Illinois); Charlie Reigeluth (Brigham Young University)

Our Distributor: National Teaching Systems, Incorporated,
1137 Broadway, Seaside, CA 93955

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OPTIMAL USE OF FINITE LAND RESOURCES

THE THREE MAJOR SECTIONS OF THE MODULE:

INQUIRY	**INTEGRATION**	**APPLICATION**
The INQUIRY presents a knowledge base for understanding the finite nature of land resources and the need for managing their use. It also offers conceptual tools for assessing the potential uses of different land forms.	The INTEGRATION presents a skills development activity in which the teacher becomes part of an anticipatory planning and decision-making process for determining the optimal, long-term uses of land resources in a specific area.	The APPLICATION presents activities and a set of guidelines for planning and implementing instructional programs on the Optimal Use of Finite Land Resources.

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During the past decade, there has been a growing public concern over the rapidly deteriorating state of our environment and the threat this deterioration poses for our ultimate survival. This environmental crisis involves a complex and interrelated set of problems which need to be addressed by both community leaders and individual citizens as they make public and personal decisions with respect to a variety of environmental problems. These problem areas include energy production and conservation, mineral and fossil fuel scarcities, food production, water allocation, urban, agricultural, and recreational land use, population dynamics, and pollution.

In order to adequately prepare citizens to meet the long-range planning and decision-making challenges which these environmental problems present, it is the goal of environmental education to develop their skills in: (1) analyzing environmental problems; (2) examining the pro and con arguments of a variety of public and private interest groups, labor, business, and government organizations; (3) exploring possible side effects of various environmental problem solutions; (4) predicting both short-term and long-term implications of local, state and national environmental programs; (5) articulating personal goals, desires, and lifestyle needs in terms of their aggregate (regional, national, or global) implications for energy use and resource allocation and (6) making long-term lifestyle decisions which are compatible with the requirements for maintaining an appropriate balance between natural system and human system functions.

Developing such capabilities can only occur through well-conceived and meaningful environmental education experiences. Curricula though geared toward people of different ages and societal levels, should have the following in common:

- Environmental education should be holistic and integrated... focusing on and clarifying the complex relationships which exist between natural systems and human systems and examining the components and reciprocal functions of both.

- Environmental education should be transdisciplinary... utilizing information from a variety of fields or disciplines (including the natural sciences, social sciences, and humanities) in order to deal adequately with the natural, social, aesthetic, and ethical dimensions of environmental problems which cut across and extend beyond disciplinary lines.

- Environmental education should be problem-focused and decision-making oriented...involving learners in real environmental problems or issues which are broad enough in scope to have regional, national, or global significance. It should engage learners in values clarification, problem-solving, planning, and decision-making processes which prepare them for dealing with environmental problems affecting both individual lifestyles and societal goals.

These characteristics are consistent with the Environmental Education Act of 1970 (as amended) which defines the requirements for informed, energy-literate, environmentally aware citizens. The Act designated the following as specific areas of concern: population dynamics, pollution, resource allocation and depletion, conservation, transportation, technology, urban and rural planning, environmental quality, and ecological balance.

In real life, these areas or "entities" occur in complex combinations. In fact, it is impossible to find a real life problem that concerns only one of these. For example, it is impossible to imagine a "transportation" problem that is not also concerned with "urban and rural planning" or "environmental quality."

In keeping with this Act, the four modules in this series of environmental education teacher training materials were designed to offer a holistic, transdisciplinary and problem-focused experience for teachers. The four modules are described below:

Optimal Use of Finite Land Resources

> Teachers will use a carrying capacity methodology to examine finite land resources, population dynamics, and available energies that must be in dynamic equilibrium in order to maintain a stable balance between the needs of urban and agricultural systems as they develop and grow, and the needs of the natural system to maintain its ecological integrity.

Energy-Intensive Urban Growth and the Quality of Life

> Teachers will examine the pattern of U.S. urban growth as influenced by economics and other considerations and compare these with considerations for enhancing the quality of life...will examine the potential of current urbanization to reverse its present trend toward high energy costs for urban society decreasing quality of life...will also examine the implications of envisioned future patterns of urbanization on energy costs and the quality of life.

Energy-Conserving Resource Utilization

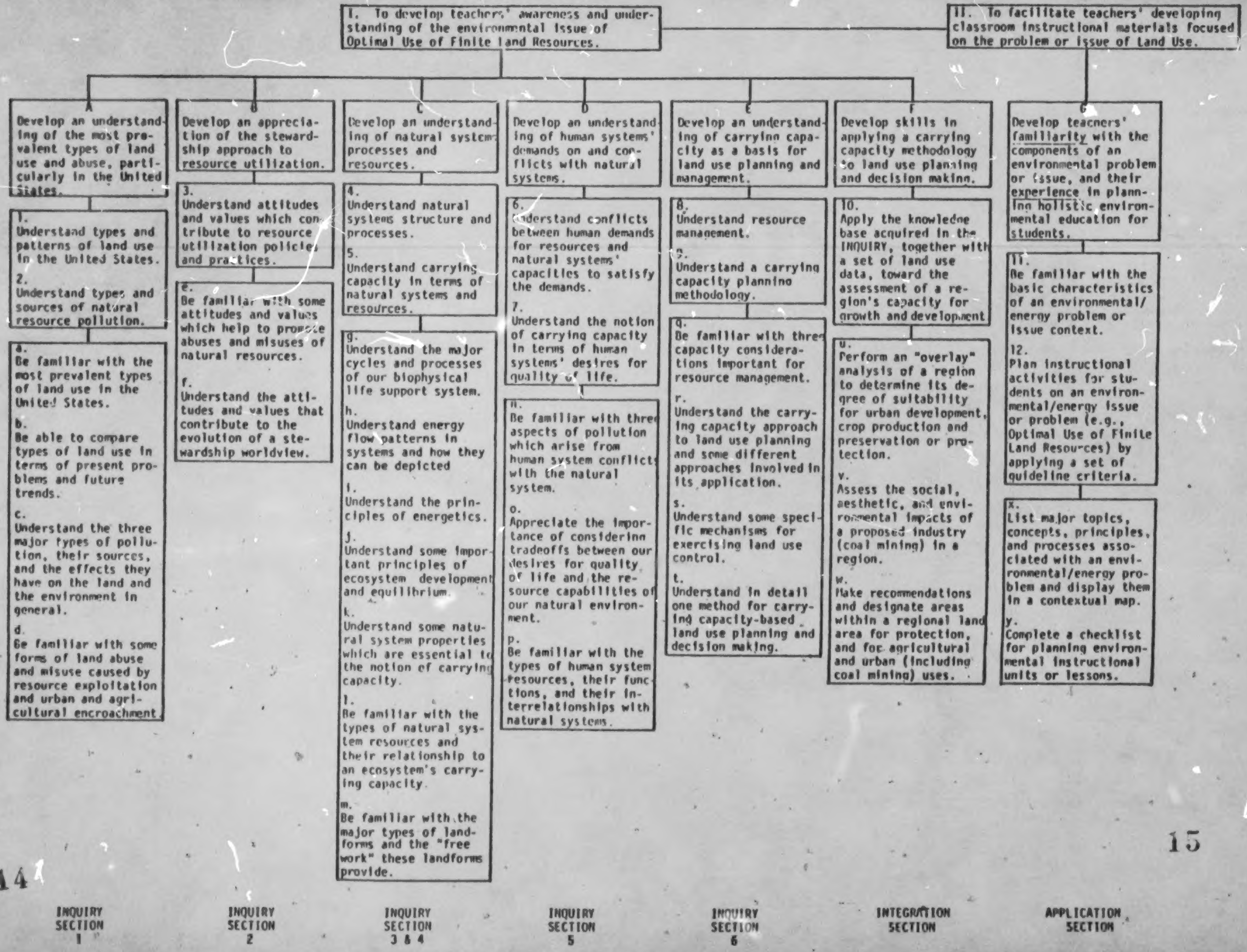
> Teachers will compare a variety of energy conservation strategies and their contributions toward a stewardship approach to resource utilization and conservation... they will analyze the conservation recommendations of the National Energy Plan and act as a Task Force Committee to propose conservation measures for a local community.

Energy Resource Delivery and Use

> Teachers will examine the role of energy in changing cultural contexts...will study the nature and uses of various conventional and nonconventional energy resources...will examine the dimensions of energy policy making...will evaluate the implications of differing means of energy delivery in terms of technical efficiency, environmental impact, and societal implications...and will apply holistic criteria to the evaluation of an energy policy plan.

This field test version of The Optimal Use of Finite Land Resources is based upon a secondary level environmental education model--with an energy-focus--that was developed by the Far West Laboratory in 1977. This model provided us with a guideline and rationale for developing--in this and the other three modules in the series--a holistic understanding of our natural- and human-fashioned environment and for presenting this understanding in the context of environmental issues rather than as a simple presentation of subject matter. Integral to the four modules are the learning processes which allow us to explore the totality of interactions between the systems of humanity and nature and which promote our environmental awareness as citizens.

The contents of this module are restated and organized into goals and objectives which appear in the following chart. The top half of the chart (boxes I, II, and A - D) indicates the broad overall goals of the module and each of its major segments (INQUIRY, INTEGRATION, APPLICATION). The lower half of the chart (boxes 1 - 12, a - y) indicates the specific teacher learning objectives for each section and each major activity of the module. These goals and objectives can serve as performance guides as you proceed through the materials. The chart reappears in its entirety at the beginning of the INQUIRY, INTEGRATION, and APPLICATION segments.



I. To develop teachers' awareness and understanding of the environmental issue of Optimal Use of Finite Land Resources.

II. To facilitate teachers' developing classroom instructional materials focused on the problem or issue of Land Use.

A
Develop an understanding of the most prevalent types of land use and abuse, particularly in the United States.

1.
Understand types and patterns of land use in the United States.

2.
Understand types and sources of natural resource pollution.

a.
Be familiar with the most prevalent types of land use in the United States.

b.
Be able to compare types of land use in terms of present problems and future trends.

c.
Understand the three major types of pollution, their sources, and the effects they have on the land and the environment in general.

d.
Be familiar with some forms of land abuse and misuse caused by resource exploitation and urban and agricultural encroachment.

INQUIRY SECTION 1

B
Develop an appreciation of the stewardship approach to resource utilization.

3.
Understand attitudes and values which contribute to resource utilization policies and practices.

e.
Be familiar with some attitudes and values which help to promote abuses and misuses of natural resources.

f.
Understand the attitudes and values that contribute to the evolution of a stewardship worldview.

INQUIRY SECTION 2

C
Develop an understanding of natural systems processes and resources.

4.
Understand natural systems structure and processes.

5.
Understand carrying capacity in terms of natural systems and resources.

g.
Understand the major cycles and processes of our biophysical life support system.

h.
Understand energy flow patterns in systems and how they can be depicted

i.
Understand the principles of energetics.

j.
Understand some important principles of ecosystem development and equilibrium.

k.
Understand some natural system properties which are essential to the notion of carrying capacity.

l.
Be familiar with the types of natural system resources and their relationship to an ecosystem's carrying capacity.

m.
Be familiar with the major types of landforms and the "free work" these landforms provide.

INQUIRY SECTION 3 & 4

D
Develop an understanding of human systems' demands on and conflicts with natural systems.

6.
Understand conflicts between human demands for resources and natural systems' capacities to satisfy the demands.

7.
Understand the notion of carrying capacity in terms of human systems' desires for quality of life.

n.
Be familiar with three aspects of pollution which arise from human system conflicts with the natural system.

o.
Appreciate the importance of considering tradeoffs between our desires for quality of life and the resource capabilities of our natural environment.

p.
Be familiar with the types of human system resources, their functions, and their interrelationships with natural systems.

INQUIRY SECTION 5

E
Develop an understanding of carrying capacity as a basis for land use planning and management.

8.
Understand resource management.

9.
Understand a carrying capacity planning methodology.

q.
Be familiar with three capacity considerations important for resource management.

r.
Understand the carrying capacity approach to land use planning and some different approaches involved in its application.

s.
Understand some specific mechanisms for exercising land use control.

t.
Understand in detail one method for carrying capacity-based land use planning and decision making.

INQUIRY SECTION 6

F
Develop skills in applying a carrying capacity methodology to land use planning and decision making.

10.
Apply the knowledge base acquired in the INQUIRY, together with a set of land use data, toward the assessment of a region's capacity for growth and development

u.
Perform an "overlay" analysis of a region to determine its degree of suitability for urban development, crop production and preservation or protection.

v.
Assess the social, aesthetic, and environmental impacts of a proposed industry (coal mining) in a region.

w.
Make recommendations and designate areas within a regional land area for protection, and for agricultural and urban (including coal mining) uses.

INTEGRATION SECTION

G
Develop teachers' familiarity with the components of an environmental problem or issue, and their experience in planning holistic environmental education for students.

11.
Be familiar with the basic characteristics of an environmental/energy problem or issue context.

12.
Plan instructional activities for students on an environmental/energy issue or problem (e.g., Optimal Use of Finite Land Resources) by applying a set of guideline criteria.

x.
List major topics, concepts, principles, and processes associated with an environmental/energy problem and display them in a contextual map.

y.
Complete a checklist for planning environmental instructional units or lessons.

APPLICATION SECTION

OPTIMAL USE OF FINITE LAND RESOURCES

BASIC PREPARATION

This Teacher Training Module is designed to be used by a small group of teachers in a self-directed, team learning mode. There is a need, however, for some initial preparations to be made in order to facilitate teachers' completing the module activities and acquiring the necessary knowledge and skills:

- Limit the number of teachers participating in the learning team to between 3-5; this number ensures the necessary level for team learning intensity, individual participation, and group cooperation.
- Select a suitable meeting place, free from distractions and outside interruptions, in which teacher learning activities can occur;
- Locate and assemble all required outside reading materials specified in the activities sections of the module;
- Reproduce these outside reading materials to prevent teachers from having to "wait around" for others to finish them;
- Arrange a suitable and mutually agreed upon schedule in which teachers can complete all readings, exercises, and activities specified in the module.

The INQUIRY presents a knowledge base for understanding the finite nature of land resources and the need for managing their use. It also offers conceptual tools for assessing the potential uses of different land forms.

INQUIRY

INQUIRY

The purpose of this INQUIRY is to (present you with a text, reading resources, and activities that will) develop your understanding and awareness of the environmental issue of Optimal Use of Finite Land Resources. This knowledge will, in turn, help to prepare you for (1) making informed personal decisions as a citizen and (2) developing comprehensive curricula for teaching students about this and other environmental issues.

The INQUIRY will orient you to the notion of carrying capacity as an approach and methodology for appreciating, planning, and managing the use of land and its resources. In doing so, the INQUIRY examines basic types of land use in the United States and the most prevalent forms of land abuse and misuse; it explores the social and economic causes of this misuse and abuse, and presents the notion of a stewardship worldview as an attitude basis for a more equitable approach to land use both now and in the future.

After completing the INQUIRY you will:

- (A) Understand the most prevalent types of land use and abuse in the United States.
- (B) Appreciate the stewardship approach to resource utilization.
- (C) Understand natural systems processes and resources.
- (D) Understand human systems' demands on and conflicts with natural systems.
- (E) Understand carrying capacity as a basis for land use planning and management.

This INQUIRY examines the Optimal Use of Finite Land Resources using a carrying capacity approach to planning. Complete all INQUIRY activities (readings, discussions, exercises); work together to alleviate any difficulties encountered in these activities; "keep things moving" on schedule; and draw out each other's personal experiences where appropriate.

Specific things to keep in mind:

1. Estimated time to complete the INQUIRY is 30-35 hours.

2. Select a location or room for teacher learning activities which is reasonably quiet and free from distractions and intrusions (and from the possibility of disturbing or intruding on others). For example, avoid classrooms, teacher lounges/rooms or libraries during regular school hours. These same areas after school would probably be useful.

3. Resources needed will include access to a photocopy machine addtional paper, magic markers, crayons or pens (for the Cognitive Map exercise); also, cardboard boxes or styrofoam for 3-dimensional models (optional).

4. Plan a teacher training schedule that will accomodate the completion of all learning activities within the time specified in #1 above. Once teachers agree upon a workable schedule, adhere to it by trying to complete the activities for each section within the allocated time--each section requires about 5-6 hours. If it appears that for a given section of the INQUIRY you are going to run over the allocated time, you can:

   - Reschedule all subsequent section activities to accomodate completing the present section; or

   - Cut off the activity(ies) and move on to the next section.

5. Locate and collect the required reading and material resources specified in the module before the learning sessions begin. This will prevent you and the other teachers from having to spend your "learning" time doing so--unless, of course, the module specifically recommends such information gathering as a useful learning activity.

6. Make certain there are sufficient duplicate copies of the readings so no one is waiting for others to finish.

   Some suggestions for reducing the amount of reading time required are:

   - Make at least one copy of all required readings and have teachers share them; or
   - Make copies of more lengthy readings only and have teachers share these; or
   - Divide up the readings and have individual or pairs of teachers summarize these for the other team members; or
   - Any combination of the above which enables all teachers to complete the required readings in a reasonable amount of time.

7. All or most of the readings can be completed by teachers on their own time in order to free up the meeting times for group discussions and other team learning activities--it makes little sense to waste these occasions on reading sessions. Individual teachers can also take responsibility for leading discussions devoted to specific reading assignments or information gathering activities. Remember to select only the most salient points, concepts, principles or ideas from your readings to present to the group.

8. Some teachers may consistently want to do one type of reading (i.e., science oriented or values oriented). Encourage teachers to do a variety of readings. Try to keep all team members involved as active participants.

9. If members of the learning team are new to one another, you are encouraged to "break the ice" with each other by discussing what personal feelings, thoughts, or ideas you have about the notions of environmental education, ecology, or energy. Perhaps some teachers will have past experiences or anecdotes. This lightens up the beginning of the learning sessions, and gives your group the chance to get their values, beliefs, and attitudes into the open, to "see where everyone is coming from."

10. At the beginning of each section, have a brief overview discussion of what the section contains.

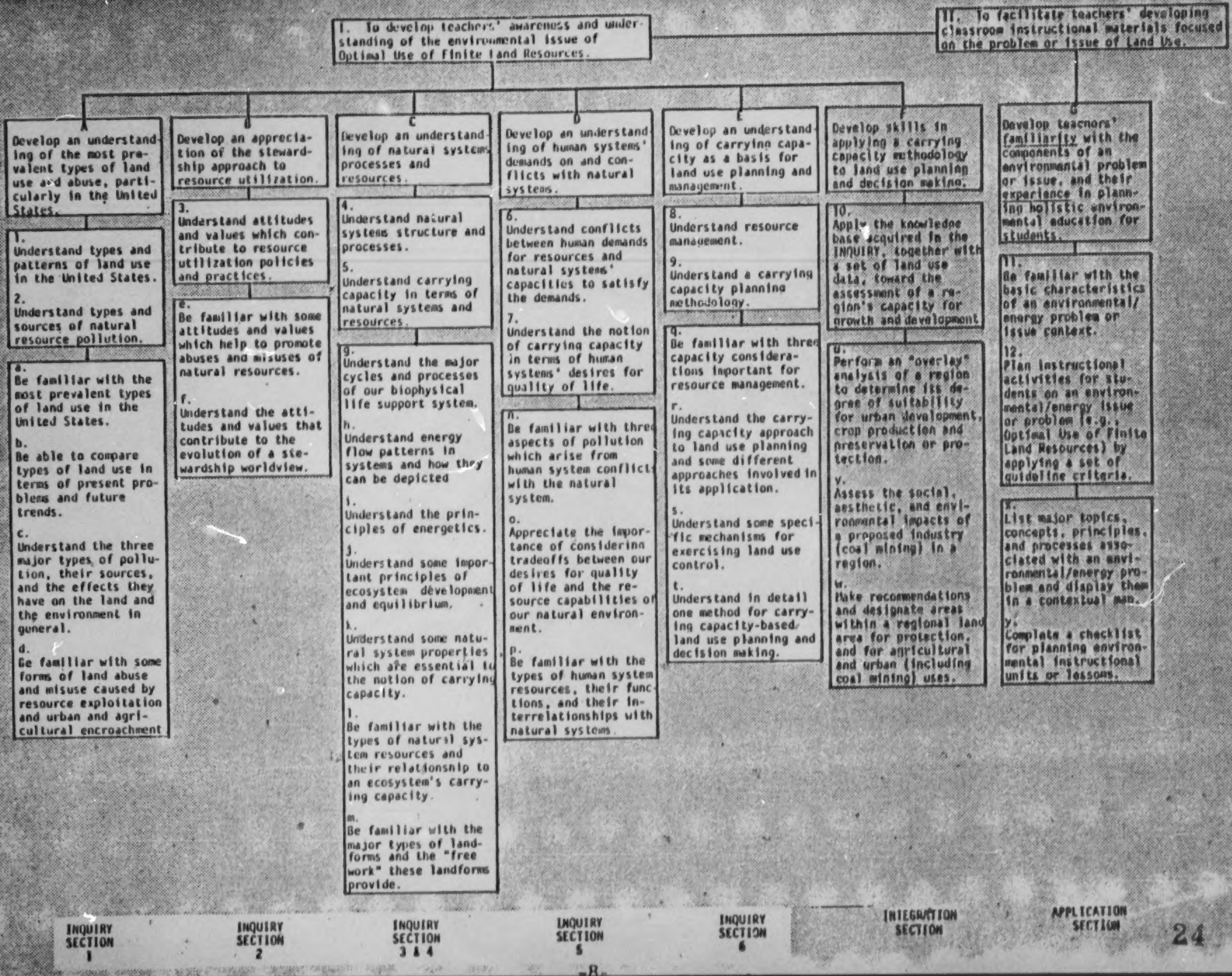
11. You are encouraged to discuss terms and concepts in order to reach a group consensus on their definitions and meanings before proceeding to the next section.

12. Some teachers may find it helpful to glance through the entire INQUIRY before beginning. For others this is not meaningful. But everyone should be familiar with the basic contents of the module (see Table of Contents and Section introductions) and the schedule for completing the sections.

13. Some of the exercises will give teachers ideas about creating materials for their students. This will be helpful in the APPLICATION, but should not be a focus of any discussion in the INQUIRY or INTEGRATION. You are encouraged to make notes for later use.

14. Answers to activity questions can be found in the Appendix, pp. 307 Please do not look through these until each activity is completed.

The Module's Goals and Objectives Chart follows. Only those goals relevant to information presented in the INQUIRY are highlighted.



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v.
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Make recommendations and designate areas within a regional land area for protection, and for agricultural and urban (including coal mining) uses.

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11.
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12.
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x.
List major topics, concepts, principles, and processes associated with an environmental/energy problem and display them in a contextual map.

y.
Complete a checklist for planning environmental instructional units or lessons.

INQUIRY SECTION 1

INQUIRY SECTION 2

INQUIRY SECTION 3 & 4

INQUIRY SECTION 5

INQUIRY SECTION 6

INTEGRATION SECTION

APPLICATION SECTION

Our rapidly increasing demand for energy to produce goods and services to satisfy our desires for a "good life" are placing severe demands on our planet for the available stores of natural resources on or within its surface. In particular, we are putting increasing pressure on our land resources for open space, recreation, food production, and urban growth.

As humankind competes for scarce land and mineral resources for its urban and agricultural growth, it contributes to the ever increasing destruction of its own life-support systems through air pollution, soil pollution, de-fertilization and erosion, and water pollution. More specifically, the application of technology to satisfy humankind's needs in the short-term has frequently created unforeseen conditions which have had destructive long-term effects on the land and to the biosphere in general.[1] For example:

- Building automobiles to satisfy our transportation needs produces unanticipated pollution of the air, as well as devastating effects on the size and structure of cities (due to their great numbers).
- Spraying large areas with pesticides to reduce the threat of insect destruction creates unanticipated contamination of fish catches and reductions in bird reproduction.
- Building dams to satisfy the need for electric power and to provide adequate water for cultivating new land for food

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[1] Biosphere refers to that layer of the Earth's surface--soil, water, air--in which all living things exist.

production has created safety hazards to the dam structure - due to silt accumulation, and ruined available land for agriculture - due to sea water backup.

- Building industrial plants along inland water-ways to satisfy the need for more goods and materials produces unwanted death of fish and loss of recreation areas (due to water pollution), and increased stress to human health (due to prolonged inhalation by inhabitants of smoke and fume-clogged air).

In the face of these situations, the question arises: at what rate and for how long can our fragile biosphere continue to supply the resources necessary to satisfy the demands put on it?

With the world population at approximately 4.5 billion[2] and projected to reach between 6-8 billion by the year 2000,[3] we seem to be only just beginning to develop a sense of the press of the world's populations on the Earth's resources to satisfy the needs and expectations for food, clothing, shelter, and luxuries. Although optimists may believe that our technological ingenuity will eventually make new land available for use (e.g., the ocean floor), old land more productive, and create new resources and methods for satisfying our needs and desires, this belief does not change the essential fact that all habitable or useable space on our small planet is ultimately finite and limited. Furthermore, with the human multiplicative faculty accelerating at its present global rate, this limit may be reached much sooner than we are prepared or are preparing for.

---

[2] Estimate of National Geographic Society, Washington, D.C. In The World Almanac, New York: Newspaper Enterprise Association, Inc., 1977.

[3] Hines, Lawrence G. Environmental Issues, New York: W.W. Norton and Co., Inc., 1973.

What are most urgently needed at local, state, and national levels of government are adequate policies for the control and management of land, "taking into account the capabilities of the land for sustained production and its capacity to support the kind of use intended."[4] Policies of this type can come about only from aware and enlightened policy-makers and from the support of an aware and enlightened public.

It is our hope that this level of awareness and enlightenment can be achieved by developing in citizens a perspective and an understanding of the complex workings of natural systems and human systems and of the interrelationship and often delicate balance existing between the two which must be maintained for their mutual and long-term survival.

In this module, therefore, teachers will focus on the "optimal use of finite land resources," examining the capacity of land to provide for agricultural as well as urban development and growth while still maintaining its ecological integrity. Teachers will engage in (1) self-directed exploration and discussion of information on the physical, social, economic, and aesthetic aspects of land and land management, (2) application of relevant planning and decision-making criteria to land use policy-making, and (3) planning land use problem-focused learning activities for students.

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[4] Dasmann, Raymond F. Planet in Peril, New York: World Publishing Co., 1972.

SECTION 1

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SECTION 1

THE USES AND MISUSES OF LAND

Upon completing this section you should

(a) Be familiar with the most prevalent types of land use in the United States.

(b) Be able to compare types of land use in terms of present problems and future trends.

(c) Understand the three major types of pollution, their sources, and the effects they have on the land and the environment in general.

(d) Be familiar with some forms of land abuse and misuse caused by resource exploitation and urban and agricultural encroachment.

This section is a general introduction to the types of uses to which land is put in the United States and to the various ways that land and the environment are being abused and steadily degraded through such uses. This, in turn, provides preparation for the next section in which the attitudes and beliefs which have contributed to land abuse and environmental degradation will be examined.

> "From time immemorial, men have travelled the seas and made use of the lakes and streams, but Man is essentially a land animal. At one time land was basic for the personal income and security of all men everywhere, and even today it is the mainstay of most of the people in most of the world. Land was and is both a means of earning current livelihood and of providing for one's family. In many times and places, land has meant social position and political power as well as economic advantage. Tribes and nations have fought wars over land throughout history. Social systems, laws, and customs have all been concerned with one or another aspect of land. Land permeates every society and economy--playing a somewhat different role in less-developed economies than in the more developed ones."[1]

In the United States and throughout the world, all economic and social activity has a basis in or is dependent on land. A person need not own land to be closely dependent on it for food, fiber, shelter, and the amenities.

Unfortunately, the total land area available in the United States and on this planet is fixed, while the total world population is growing at a rapid rate, thus resulting in a steadily decreasing availability of land area per person. The real concern at the present, however, is not for the security of land, but for the continuing availability of products and services originating from the land.

Although the United States is, at present, in a relatively comfortable position regarding available land area, products, and services, if our population continues to rise unchecked, the day will come when the sheer space per person will indeed be a limiting factor. For example, even now, desirable land in choice locations is no longer plentiful (e.g., the major seaport areas of New York City, Boston, Los Angeles, and San Francisco).[2] In addition to this growing scarcity, there are serious problems of land degradation and land misuse which have to be corrected. Alert citizens will have to take positions on these concerns as voters and participants in society.

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[1] Clawson, Marion, America's Land and Its Uses, Baltimore: The Johns Hopkins Press, 1972, p. 1.

Before examining specific abuses and misuses of land, however, we will examine the major types of land use in the United States, some important space-land relationships, and some important considerations involving environmental quality.

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[2] Land Tenure in the United States: Development and Status, Washington, D.C.: U.S. Government Printing Office, 1969.

a. Overall Land Use in the United States

In contrast to the rest of the world, the United States has been blessed with land which has great productive capabilities. Less than 15 percent of U.S. land is classified as unusable wasteland[3] (although even these deserts, tundra, and mountains have some value for wildlife, mineral production, watershed, and other purposes). Other countries in the world have higher percentages of land mass, but more limited productive capabilities, e.g., Russia and Canada with huge Arctic or near-Arctic land areas; Brazil with a vast and "unused" Amazon jungle; Australia and China with large desert or near-desert areas.

The abundance and productivity of land in this country has contributed to its exploitation as a resource--in a variety of ways--most of which are included in the following:

- Agricultural (crop production) use
- Grazing (livestock production) use
- Forest and woodland use
- Urban use
- Recreational use
- Other uses (e.g., water storage and management, transportation, mining, defense, idle land)

Agricultural, grazing, and forestry constitute the three largest uses of land when considering number of acres involved, while urban and recreation are the most critical when considering land and its direct relationship to the daily concerns of most of the people.[4]

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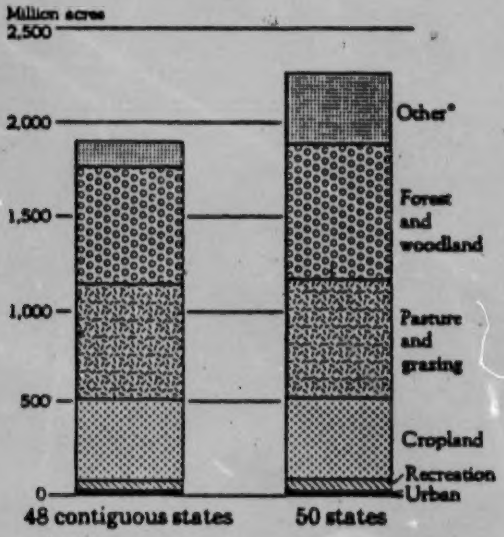
[3] Clawson, p. 3.

Figure 1 presents data showing the types of land use in the United States. This data--though only approximate due to non-standard land use classification systems and incomplete censuses--has not changed significantly since the 1920's and is not expected to change much even into the year 2000 or later.[4]



*Includes transportation, military, water management and other uses; also includes marshes, bare rock areas, sand dunes, deserts, etc.; also includes all unaccounted for areas, including idle land.

Figure 1. Land Use in the United States[4]

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[4] Clawson, p. 4.

[5] Clawson, M., Held, R., and Stoddard, C., Land for the Future, Baltimore, Md.: Johns Hopkins Press, 1960.

[6] Clawson, America's Land and Its Uses, p. 4.

Despite this picture of overall constancy, some changes in the pattern of land use have occurred during the past decades. For example, the amount of land used for cropland has declined, while land areas used for urban and recreation purposes have increased.[7] However, while these changes are significant in relative percentage terms, they are still small when compared to the nation's total land area.

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[7] Cochrane, Willard W. The City Man's Guide to the Farm Problem, Minneapolis, Minn.: University of Minnesota Press, 1958.

b. Changing Space-Land Relationships

Over the last few centuries, a major industrial and technological revolution has created a worldwide communication and transportation network. This network has succeeded in shrinking the world by greatly reducing the time it takes to send messages or to travel between points; it is also expanding our world by opening up many new areas for access by people everywhere.

The "shrinking" of space-time relationships in the United States due to communication and transportation advances has had a substantial impact on land use where the pattern of local markets for land and its products has changed to a pattern of regional or national markets. For example, agricultural and forest products are distributed nationwide; people seek outdoor recreation hundreds, even thousands of miles from their homes.

The net effect of this shrinkage is the growing realization that land problems must increasingly be studied from a national viewpoint where the environment of any one area is seen as being determined in part by conditions in other areas.

c. Environmental Quality and Land Use

In the past decade or so, there has been a gradual awakening of concern over the quality of the environment. People's attention has begun to divert from the processes of producing goods and services to the impacts of the consumption of goods and services on the natural environment. In particular, it is now apparent that a great deal of attention needs to be paid to the wastes or residuals engendered from the consumption process. The realization has begun to dawn on us that every ton of input reaching the consumer has a counterpart or reappears in some form of residual or waste tonnage of output, whether measured at the individual, city, or regional level, or measured in terms of gases, liquids, or solids. It is also becoming evident that residuals may represent an unplanned impact, as when household paper wastes are burned to create added air pollution.

As people become more aware of the environmental impacts of their consumption, they qre likely to demand new approaches to solving environmental problems which will have considerable effect on land use. For example, as more land continues to be used for landfill or garbage dumps, agricultural or suburban development practices that dump a great deal of sediment into streams will probably be curbed; or the activities of poultry

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producers or cattle feeders, who contribute to the over-fertilization of waters and thus to the growth of algae, may be restricted.

A further consequence of this growing concern over consumption impact and environmental quality is that changes in the amount or type of land use will likely become more difficult as populations increase and the previously "separate" actions of individuals and groups begin to impinge more and more on their neighbors. This situation is described most effectively by Clawson:

> "In the days of the frontier, a piece of land could be transformed from forest or open prairie into cropland without disturbing anyone very much; today, when a superhighway is built through an urban area, thousands of people may be disturbed, and some may lose their homes; controversy is inevitable, however beneficial the change may be overall. Land use changes in the future will generally be still more difficult--upsetting to many people, hence resisted, while at the same time beneficial to others and supported by them. A country, no less than a person, encounters new problems as it sheds the old ones." [8]

As the population continues to grow and the competition for the use of land and its resources continues to rise, a greater and greater impetus will need to be given to seeking comprehensive, equitable, and long-term land policies.

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[8] Clawson, p. 6.

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d. Pollution and Environmental Health

In our single-minded pursuit of continued economic growth and prosperity--measured prediminantly in the production of goods and services--we have begun to experience the physical limits to unrestrained growth. These limits manifest themselves in a variety of small-scale ecological disasters and in the steady deterioration of environmental quality, e.g., oil spills, wildlife extinction through hunting and pesticide contamination, land denudation through strip mining, soil erosion through clear-cutting of trees, urban sprawl and congestion, noise and air pollution, etc. Indeed, we have begun to be aware that we are inhabiting an all too tiny planet with resources and space too limited to accommodate our insatiable demands for urban, agricultural, and recreational development, plus a limited capacity to withstand the effects of such development.

The capability of both our natural and human environments to accommodate or absorb intense development and change without experiencing conditions of instability and attendant degradation is becoming a significant issue in the United States and in many parts of the world. In view of current trends and practices of urban growth and development, the growing concern is the ability of our environment to sustain particular levels of activity (e.g., industrial waste disposal, single car commuting) which in some areas, may already have exceeded the appropriate levels (e.g., New York City, Los Angeles) thereby rapidly foreclosing opportunities to manage our resources effectively and to control environmental degradation.

Aggravated by population growth, the familiar problems of air, water, and land pollution, inadequate world food supplies, and the depletion of natural resources all contribute to or reflect increasing damage to the physical, biological, and aesthetic welfare of our planet.

> "Pollution is an undesirable change in the physical, chemical or biological characteristics of our air, land, and water that may or will harmfully affect human life or that of desirable species, our industrial processes, living conditions, and cultural assets; or that may or will waste or deteriorate our raw material resources. Pollutants are residues of the things we make, use and throw away. Pollution increases not only because as people multiply the space available to each person becomes smaller, but also because the demands per person are continually increasing, so that each throws away more year by year. As the earth becomes more crowded, there is no longer any "away." One person's trash basket is another's living space."[9]

The "throw away" pollutants and the pollutants which are the inevitable by-products of transportation, industry, and agriculture may well be the crucial limiting factors for humankind's continued economic growth. For example, in the "undeveloped" nations (70 percent of the world's population), lack of available food and resource shortages are associated with both pollution and disease caused by human and animal wastes, while in the affluent nations

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[9] From "Waste Management and Control," a report by the Committee on Pollution, National Academy of Sciences (1966); quoted in Odum, Fundamentals of Ecology, Philadelphia, Pa.: W.B. Saunders Co., 1971, p. 432.

(30 percent of the world's population), agricultural and industrial chemical pollution is the major causal agent in human disease.[10] Furthermore, the nearly global pollution of air and water, mostly by the "developed" countries, poses a threat to everyone.

In order to increase our understanding of the impact of pollution on our environment, let us now briefly examine the major types of pollution, their causes, and effects.

(1) Air Pollution

In 1969 some 281 million tons of major pollutants were dumped into the air in the United States alone.[11] The top five pollutants in terms of the tonnage emitted per year are, in decreasing order:

- carbon monoxide,
- hydrocarbons,
- industry
- sulfur oxides, and
- oxides of nitrogen.

The major contributors of this pollution in decreasing order are:

- transportation,
- fuel combustion from power plants,
- industry
- forest and agricultural fires, and
- incineration of solid wastes.[12]

The short-term effects of atmospheric pollution are evident in the air quality problems of our major cities and in the areas near large power plant installations.

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[10] Odum. Fundamentals of Ecology, 1971, p. 432.

[11] Based on an Environmental Protection Agency estimate.

[12] Based on an U.S. Department of Health, Education, and Welfare estimate in 1970.

The long-term effects of disturbing the atmosphere are not as visible as air pollution, but they also require our immediate attention. They include:

- climate changes, including rising temperatures from increased heat retention due to large amounts of carbon dioxide (a by-product of combustion);
- health hazards for humans and animals from chemical poisoning (carbon monoxide) or toxic metals (lead, mercury);
- interference with photosynthesis processes due to particulate build-up, which increases the reflection of solar energy.

(2) Water Pollution

Water is considered polluted when a substance or condition is present which makes it unusable for a specific purpose. Since these specific purposes vary (i.e., water unsuited for drinking may be satisfactory for industrial use, water unsuited for swimming may still be satisfactory for fish, water unsuited for fish may still be satisfactory for hydroelectric power generation), the judgment as to what constitutes water pollution becomes a point of controversy. This situation is further complicated by the great difficulty which exists in measuring water quality even when standards are clear.

The major sources of water pollution are:

- domestic sewage, animal manure, and other oxygen depleting wastes;
- disease causing agents (bacteria, viruses);
- inorganic chemicals and minerals;
- synthetic organic chemicals and oil;
- plant nutrients (nitrates and phosphates);

(3) Land Pollution: The Solid Wastes Problem

Each year we create approximately 4.3 billion tons of solid waste (12,000,000 tons each day).[14] This yearly output is sufficient to cover the entire state of Connecticut one foot deep in trash. Each one of us produces over 20 tons of this waste either directly or indirectly each year in the forms of:

Direct Wastes

- paper and paper products,
- metal cans,
- bottles and jars,
- plastics,
- rubber,
- metal squeeze tubes.

Indirect Wastes

- agricultural,
- mining, and
- industrial wastes.

Agriculture supplies the single biggest contribution to solid wastes (over 50 percent of the total), followed by mineral wastes from mining and processing. Domestic or residential wastes represent only about 6 percent of the total. At the current rate of increase of 5 percent per year, we could easily double or triple our solid waste output before the year 2000.[15]

As yet, disposing of wastes does not pose as serious a threat to human health as do air and water pollution. Still, open dumping and improperly designed landfills pollute land, air and water, pose fire hazards, create unsightly nuisances, and breed germs, insects, and disease-carrying rodents. In addition, burning of wastes adds to air pollution, while agricultural wastes cause major ecosystem disruptions.

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[14] Niessen, Walter R. "What Do We Do With Rubbish?" Technology Review, March-April, 1972, p. 11.

[15] Ibid.

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e. Other Forms of Land Abuse and Misuse

> "Man is a constant modifier of the land. Often, his modifications have been beneficial, as large areas of barren land have been protected and made productive. But man's ecosystem simplification has not always brought positive results. Soil has eroded from millions of acres that were overgrazed and overfarmed through ignorance and greed. Far too often our natural forests have been cut without concern for replenishing and preserving this resource for future generations. To satisfy our almost insatiable energy needs, we gouge out vast areas of our land in strip mining with far too little attention to repairing the scars. Although our planet is vast, land is an inelastic resource. Probably no more than 12 percent of the earth's surface is arable."[16]

(1) Urban Sprawl

Presently, more than 20 percent of the world's population lives in urban areas with a population of 100,000 or more (this percentage is expected to double by the year 2000).[17] In the United States, approximately 70 percent of the population lives in city and urban areas that occupy less than 11 percent of the total land area. At the present rate of urban growth and expansion, it has been projected that, by the year 2000, the U.S. will consist of four gigantic megalopolises: BoWash, stretching continuously from Boston to Washington, D.C.; ChiPitts, sprawling from

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[16] Miller, p. 151

[17] United Nations Demographic Yearbook, 1970.

Chicago to Pittsburg, SanSan, connecting San Francisco to San Diego; JaMi, extending from Jacksonville to Miami. These super-urban areas would be supplemented by numerous other large urban areas around the rest of the country.[18]

Although there is no current shortage of land in the U.S., the expected increase in urban land area will involve a number of problems and tradeoffs, including:

- a potential decrease in environmental quality in large and rapidly growing urban regions,
- a lack of convenient and environmentally suitable sites for public structures, utilities, sanitary landfills, etc.,
- loss of prime agricultural land, and
- increasing threats to wildlife, national parks, forests, wilderness, and scenic areas (due to increased recreation and uncontrolled development of vacation homes).

In addition, continued expansion of urban sprawl will also create or intensify a wide range of internal problems regarding energy supplies, noise, transportation, poverty, disease potential, racial tensions, physical and mental disorders, crowding, crime and delinquency, housing, individual stress, and drug abuse.

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[18] Greenwood, N. and Edwards, J.M.B. Human Environments and Natural Systems: A Conflict of Dominion, North Scituate, Mass.: Duxbury Press, 1973, pp. 214-215.

(2) Surface Mining

In surface mining (of which strip mining is one form), the earth's topsoil and rock are removed in order to obtain coal, sand, gravel, stone, copper, iron, and a host of other metal and mineral resources. Since World War II, approximately 4 million acres or 6200 square miles have been disrupted by surface mining (mostly in the Appalachia region). Only about one-third to one-half of the exposed acreage has been restored or reclaimed.[19]

The four types of surface mining are:

- open pit,
- area strip,
- contour strip, and
- dredging.

The most destructive of these is probably contour strip mining. Stripping the surface of the land for valuable ores and minerals creates ugly scars on landscapes from huge pits and mountains of over-burden. Strip mining also disrupts the flow of ground water, lowers water tables (due to the high amounts of water required for the mining operations), destroys aquifers, washes away or buries fertile soils, damages or destroys watersheds (causing rapid land erosion), pollutes air with noxious fumes and gas, and pollutes streams and rivers with acid and sulfide runoffs (which, in turn, kill plant and animal life).

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[19] Miller, p. 169.

(3) Deforestation

Deforestation has become recognized over the last 50 years as a worldwide problem: Europe has lost approximately 90 percent of its forests (since the Middle Ages), the United States has lost about 50 percent (since the 17th Century), the Phillipines has cut down about 50 percent of its forests, Brazil about 40 percent, and Africa, 33 percent.[20]

Much of this damage has been due to "slash and burn agriculture" (clearing forest areas for crop production) and to clearcutting for timber.

Deforestation destroys ecosystems by destroying wildlife habitats, causing extensive soil erosion and nutrient depletion, degrading water quality, and marring beautiful landscapes with ugly scars that take many, many years to heal.

(4) Wildlife Extinction

From an estimated 500 million species that may have existed on this planet since life began, biologists estimate that there may be approximately 2 million different species of plants and animals (including humans) existing today. Although most extinctions were due to natural causes (climate and geological changes), humankind now appears to be the major influence in directly or indirectly hastening this natural process.

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[20] Greenwood and Edwards, pp. 124-125.

The major cause of various forms of human-induced wildlife extinction are through loss or alteration of habitat from urban, agricultural, and recreational encroachment. Other major causes include: (a) direct killing through poisoning for livestock and crop protection and through hunting for food, fun, or financial gain, (b) pollution, expecially from DDT, other pesticides and herbicides, and (c) introduction of competing or predatory species.

f. The Question of Causes

Because land abuse and environmental damage can be traced to a number of contributing causes,considerable disagreement has developed among those examining this problem. Some find our habitat threatened primarily by rapid population growth and emphasize the need to bring the birthrate under control.[21] Others consider economic growth and high living standards to be the basic cause of environmental damage and urge a no-growth "stationary state."[22] Still others point out the sharp increase in new products and production techniques that took place in the late 1960's and recommend that technological innovation be somehow channeled away from environmentally harmful avenues.[23]

The great value of these differences of opinion lie not so much in their individual truths as in their illustrating an important aspect of the environmental problem--its complex and multi-causal nature.

The issue and subsequent controversy over causality has been greatly stimulated by the publicity given a Massachusetts Institute of Technology computer study which explored the issue of economic growth and its contribution to the decline in the well-being of the environment.[24] Although environmental damage is primarily physical and biological, the main reason it persists as shown in this study, is economic. The burden of paying for remedial action to our foul air, contaminated water, denuded and polluted land, and other abuses of the habitat is frequently shifted on to the public by producers who do not wish to themselves bear abatement costs. Furthermore, protecting the environment involves using resources that are presently being used to produce goods--and profits.

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[21] Ehrlich, Paul R. The Population Bomb, New York: Ballantine, 1968.

[22] Olson, M. and Landsberg, H. (eds.). The No-Growth Society, New York: W.W. Norton and Co., Inc., 1973.

[23] Commoner, Barry. The Closing Circle, New York: Alfred A. Knopf, 1971.

Another important ingredient in this causality controversy and, indeed, in the general environmental problem is the issue of free choice. This concept underlies all economic activity and embraces not only local, state, and federal government decisions on policy and spending, but also private or personal attitudes towards consumption and life style needs. The resource-use choices in government and private sectors are not mutually exclusive: what is done in one sector affects what can be done in the other. Therefore, controlling resource use and pollution, and protecting the environment, should be viewed as components of a broad and interacting social system.

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[24] Meadows, D.H., Meadows, D.L., Randers, J., Behrens, III, W.W. The Limits to Growth, Washington, D.C.: Universe Books, 1972.

The economic aspects of resource use and decision making will be taken up again in later sections of this module when we examine land potential (Section 4) and land use management and control (Section 5).

In the next section, however, we will explore another important aspect of the environmental problem--our attitudes, beliefs, and values.

ACTIVITIES

FACILITATING NOTES

1. For Activity I, you can use Figure 1 (p. 19) to estimate the approximate % of total land use. You can also estimate this from Miller, p. 153.

   With the exception of Chapter 9 (all teachers should read this), teachers should divide up the responsibility for reading Chapters 3-8 in Clawson. Do the same for Chapters 9-11 and 14 in Miller if this reading is selected instead of Clawson.

2. For Activity II, you and the other teachers can divide up the responsibility for reading the Greenwood and Edwards chapters. Make certain you share this information when you meet for group discussion.

   The teacher who reads Chapter 9 in Greenwood and Edwards should also read Chapter 10, pp. 168-178 in Miller.

   For comparative purposes, you can set up all necessary information--sources of pollution, proposed solutions, and their feasibility ratings--in a chart as follows:

SOURCES OF POLLUTION	PROPOSED SOLUTIONS	RATING: FEASIBILITY OF PROPOSALS
I. *(greatest contributor)*		
II.		
III.		
IV. *(least contributor)*		

OBJECTIVES: (a) To be familiar with the most prevalent types of land use in the United States.

(b) To be able to compare these types of land use in terms of present problems and future trends.

READINGS: Clawson, Marion. America's Land and Its Uses, 1972: Chapter 9, "What of the Future?", pp. 151-159; Chapters 3-8.

Dasmann, Raymond F. Planet in Peril, 1972: Chapter 3, pp. 112-124, pp. 127-169, and Chapter 5, pp. 173-192.

or

Miller, Jr., G. Tyler. Living in the Environment: Concepts, Problems, and Alternatives, 1975: Chapters 9-11, pp. 123-200; Chapter 14, pp. 254-263.

TO DO: Have a group discussion to share your and the other participants' understandings of the five major uses of land (agriculture, grazing, forestry, urban, recreation), and the other miscellaneous land uses in the United States. Compare or contrast these land uses in terms of the following:

- the approximate percentage of total land currently devoted to such use (all 50 states);
- the major inputs required to drive or maintain such use (e.g., types of natural and/or human resource requirements);
- the major outputs produced by this land use (e.g., types of products, materials, or services produced);
- current use, misuse, or abuse problems associated with this type of land use;
- possible or probable future trends with regard to such land use.

Summarize your understandings and findings in the chart which follows:

Type of Land Use	Approximate % of Total Land Use (50 States)	Major Inputs (Natural & Human Resources Required)	Major Outputs (Products: Goods, Services)	Current Use or Misuse Problems	Possible or Probable Future Trends
Agricultural (Crop Production)					
Grazing (Livestock Production)					
Forest and Woodland					
Urban					
Recreation					

Miscellaneous:				
● Water Storage & Management				
● Transportation				
● Mining				
● Other				

OBJECTIVES: (c) To understand the three major types of pollution, their sources, and the effects they have on the environment in general

(d) To be familiar with some forms of land abuse and misuse caused by resource exploitation and urban and agricultural encroachment.

READINGS: Greenwood, Ned, and Edwards, J.M.B. Human Environments and Natural Systems, 1973, Chapters 7, 8, and 9.

Miller, Jr., G. Tyler, Living in the Environment: Concepts, Problems, and Alternatives, 1975, Chapter 10, pp. 168-178: Surface Mining.

The teacher or teachers who elect to read and discuss Chapter 9 (above), should also read these pages in Miller.

TO DO: In a discussion with the other participants:

- Identify the top three or four sources of pollution and land abuse (e.g., industry, households, etc.);

  or, for the more ambitious,

  rank in decreasing order all sources in terms of their degree of contribution to overall pollution and land abuse;

- Propose some ways to reduce or prevent the various types of pollution and land abuse in reference to each of these sources; discuss alternative ways also;

- Rate your proposals, as best you can, on the basis of their technical, economic, or political feasibility. You may use the following scale if you wish:

1	2	3
Impractical; cannot be done with available methods/technology; overwhelming social/political resistance.	Feasible; but some technical difficulties or social/political resistance involved.	Very practical; can be done with available methods/technology; little or no social/political resistance involved.

SECTION 2

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SECTION 2

USE OF ENVIRONMENTAL RESOURCES: A STEWARDSHIP WORLDVIEW

Upon completing this section you should:

(e) Be familiar with some attitudes and values which help to promote abuses and misuses of natural resources.

(f) Understand the attitudes and values that contribute to the evolution of a stewardship worldview.

This section presents some events, attitudes, and beliefs which have contributed to the misuse and abuse of our land and natural resources in the United States. It also presents an image of a worldview that is consistent with certain attitudes and values inherent in a protective and conserving approach to nature, land, and resource management.

In order to understand humankind's continuing pattern of environmental misuse and abuse, we will briefly examine some basic assumptions, attitudes, and beliefs which have led or contributed to this pattern. Then, by way of contrast, we will examine some newly emerging values which offer a basis for developing a more protective and conserving attitude towards nature and towards managing our precious resources.

a. Attitudes Contributing to the "Land Abuse Ethic"

In previous eras, when land and its resources were in great abundance and populations were small, humankind's exploitation of nature was easily accomodated. In more recent times, however, where populations have swelled and land and its resources have become far less abundant, the impact of our continuing habits of exploiting nature are being felt as threats to both the quality of our environment and to the maintenance of our standard of living.

In order to understand how Americans' exploitative nature has been nurtured, let us briefly characterize some of the major beliefs, attitudes, and values which have been instrumental in shaping our interactions with nature.

(1) The Frontier Philosophy

In the early history of America, the land and its resources were considered virtually inexhaustible, free, and to be had for the taking--if not close at hand, then on the way west. The precedence for our present "land ethic" was established in the then unlimited expanse of land, profusion of wildlife, and vast quantities of mineral resources. The presence of these great abundances encouraged the belief that resources were unlimited and the subsequent belief in a free-for-all system of wealth-getting and entrepreneurship which still prevails in this country.[1] Furthermore, this early superabundance of land and resources seemed also to foster a belief in the principle of laissez faire[2] which has severely handicapped our present abilities to obtain the degree of cooperation necessary to manage and preserve our natural resources (e.g., our seeming reluctance or inability to control migration patterns, urban sprawl, industrial pollution).

(2) The Attitude of the Transient Exploiter

A sense of belonging or attachment to the land has not been characteristic of most Americans. With the exception of the farmer, the general attitude has been one of the transient exploiter "who seeks to gain wealth by the use of land or exploitation of its resources, but feels that his true home is elsewhere and hopes to return with his wealth to some urbane and settled place."[3] This attitude of non-attachment and non-committment has been encouraged in the United States over time in various ways of which the following are only a few:

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[1] Webb, Walter W. "The Frontier and the 400 Year Boom" in The Turner Thesis, George R. Taylor (ed.), Boston: D. C. Heath & Co., 1956, p. 94.

[2] Laissez faire is defined in Webster's dictionary as a philosophy or practice characterized by deliberate abstention from direction or interference with individual freedom of choice and action.

[3] Dasmann, Raymond F. "Man in North America," in Future Environments of North America, F. F. Darling and J. P. Milton (eds.), Garden City, NY: Natural History Press, 1966, p. 328.

- the activities of hunters and trappers, miners and lumbermen, livestock producers and some farmers who exploited an area's resources and then left;
- the government's failure to establish early control over land use in the public domain, and its early failure to establish adequate provisions for the disposal of land;
- the encouragement of the American economy which provides greater profit margins for short-term investment and quick liquidation than for long-term investment and sustained yield;
- the dispersed nature of urban living which forces people to live many miles distant from where they work and recreate;
- the extreme mobility of Americans;
- a general adversary attitude towards nature in which Americans prefer to shape the land to suit their enterprises rather than to adapt their enterprises to the shape of the land, i.e., the "bulldozer mentality."

(3) The Appeal of Technology

Americans tend to show a preference for the quick efficiency of the machine and an impatience with the slow processes of nature, e.g., building a dam to stop floods "for all time" rather than suffering the tiresome day-to-day problems of watershed management, which requires accomodating natural flood cycles; or developing special "high yield" crops rather than relying on natural growth cycles.

(4) The Attitude of Economic Determinism

The actions of most Americans towards their environment suggest that they accept an economic determinism as a rule of life. That is, we seem to believe that the very nature of our economic and social system forces a pattern for the future on us whether we like it or not, e.g., we seem to accept economic "growth," "progress," and greater and more technology as inevitable.

(5) The Predominance of Self-Interest

We vote for measures to preserve the environment only in those areas where our own economic interests will not be affected. Thus, the personal profit motive still largely characterizes the current situation. "--The individual's quest for economic advancement still rides over his social conscience and smothers the development of any true ecological conscience."[4]

The above examples are by no means exhaustive and are meant only to illustrate the prevailing predominant American beliefs, attitudes, and values which are counter-productive to notions of protecting, conserving, or managing nature and its resources. We will now consider a set of values which embrace and encourage such notions.

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[4] Ibid., p. 332.

b. Characterization of a Stewardship Worldview

A worldview addresses our collective attitudes, beliefs, and assumptions which change over time. Any period of transition in which worldviews are changing usually generates some conflict.

The focal point in today's evolving worldview is the effect of our attitudes and beliefs on our actions and the subsequent effect on both the human and natural systems. Many of our past and present assumptions about growth, technology, natural resources and the quality of life have recently been challenged or proven incorrect.

> "We have plunged headlong for more than half a century into development of a technological direction unprecendented on this planet, and are now finding that its direction is unsustainable, its effects undesirable, and its replacement necessary if we are to ensure the soundness, stability, and permanence of our society, our individual freedom and opportunity for personal growth, and the overall health and well-being of our society."[5]

The worldview that is currently evolving must accomodate new values and new concerns if it is to enhance our quality of life while maintaining a harmonious relationship with the biophysical systems that support our existence.

This new worldview, which we call a stewardship worldview, recognizes the need to re-evaluate our present dreams and the unrealistic demands we make on our land, energy resources, and life support systems to fulfill our desires. This stewardship worldview is characterized here according to its beliefs about:

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[5] Bender, Tom. Sharing Smaller Pies, Portland, OR: RAIN, 1975, p. 5.

- natural systems
- human relationships
- the relationship of humanity and nature

(1) Beliefs about Natural Systems

> "Though human society can develop in many substantial ways, by using up its capital stock of non-renewable resources, it must ultimately come to terms with and live in a sustainable equilibrium with the biosphere."[6]

The stewardship view of natural systems is based on the notions that: (a) humankind can cause irreversible changes in nature, (b) our environmental resources are finite, (c) our environment has a limited capacity to absorb waste and pollution and to recycle it harmlessly, and (d) a finite world with finite resources cannot support an indefinitely expanding population, technology or economy. Thus, the stewardship worldview recognizes that a rational, conserving, and protective approach to the utilization of our land and environmental resources is necessary to ensure a high quality of life for this and subsequent generations.

Consequently, the health or dynamic equilibrium of our supportive natural systems becomes a primary criterion of the stewardship worldview (and its orientation toward resource utilization policies and practices). Ultimately, it is the condition of our natural systems which provides the actual physical base for the survival and welfare of humankind.

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[6] Science Council Committee on the Implication of a Conserver Society, "Toward a Conserver Society: A Statement of Concern," Science Forum, Vol. 9, No. 3, June, 1976.

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(2) Human Relationships

The stewardship worldview proposes that humankind be guided by a principle of equity which, as we will see, has important implications in different realms of human interactions. Equity, as it applies to man's relationships with this "finite pie" of natural resources (land, water, minerals, etc.), is an elusive concept to explicate. The most common conceptions of equity, relative to discussions of energy and environmental issues, focus on equitable distribution of resources and social versus environmental quality.

Discussions on resources usually center on the inequitable distribution of resources, goods and services between the developed and the less developed nations, between urban and rural areas, or between advantaged and disadvantaged socio-economic populations. Discussions on the latter involve the job earning rights of the less affluent which are being endangered by mechanical "energy slaves" and also by environmental changes.

Equity, in terms of the stewardship worldview, applies to resource distribution, and is concerned with an equitable distribution of external costs involved in resource utilization. For example, those who are responsible for polluting our waterways are rarely the ones who pay for the damages or corrective actions. The costs are usually "distributed" to the taxpayers. However, distributing these external costs to those responsible would be a more equitable practice.

The notion of equity also encompasses individual and community access both to primary resources and to the goods and services produced from them. It further ensures access to learning opportunities as a means to become a producer of goods and services. Whether this is access to information, job training opportunities or formal education, it is a means to developing opportunities for meaningful work in our society--work that brings more satisfaction than an income. It is a means of self-expression and a way to establish family and community connections.

In Sharing Smaller Pies, Tom Bender outlines some means for achieving equity:

> "Equity is not only possible, but is necessary to restore choices of where and how one lives. It is necessary to restore alternatives to our unaffordably costly urban systems. It can be achieved through introduction of appropriate technology; through control of organization size; by equalizing income and available wealth; by establishing equal access to learning opportunities, health care, justice, and other services; and by assuring everyone the opportunity for meaningful work. It can be achieved by returning to individuals the responsibility and control of their lives, surroundings, and social, economic, and political systems; by ensuring freedom to not consume or depend upon any systems other than one's own abilities; and by encouraging the ownership of the tools of production by the people who do the work, thus increasing the chances of developing a balanced, affluent, and stable society."[7]

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[7] Bender, Tom. Sharing Smaller Pies, p. 17.

(3) Relationship of Humanity and Nature

Our ideal worldview can be further characterized in terms of humanity's relationship with natural systems, and the notion of "stewardship" best describes this relationship. Stewardship, as defined in Webster's terminology, is "the individual's responsibility to manage his life and property with proper regard to the rights of others."[8] "Others" means future generations, and, we would add, the rights of natural systems.

There are other terms and concepts associated with the notion of stewardship which further illustrate its dimensions, as exemplified by the following excerpts from an article by Wendell Berry entitled "Exploitation and Nurture."[9] Berry outlines the primary concerns of stewardship in terms of:

NURTURE	"the care of the earth is our most ancient and most worthy, and, after all, our most pleasing responsibility. To cherish what remains of it, and to foster its renewal, is our only legitimate hope."
PROTECTION	"In all of these systems (human and natural) a fundamental principle must be the protection of the source: the seed, the food species, the soil, the breeding stock, the old and the wise, the keepers of memories, the records."
KINDLY USE	"Understanding, imagining, living out the possibility of 'Kindly Use' can dissolve the boundaries that divide people from the land, and its care, which together are the source of human life."

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[8] Webster's New Collegiate Dictionary, Springfield, MA: G. M. Merriam Company, 1977, p. 1142.

[9] Berry, Wendell. "Exploitation and Nurture," CoEvolution Quarterly, Spring, 1977, pp. 57-71.

INDIVIDUAL RESPONSIBILITY

"Kindly use demands an intimate knowledge, the most sensitive responsibleness and responsibility."

"No matter how general may be a person's attitude toward the world, his impact on it must become specific and tangible at some point."

"FUTURE IS NOW"

"It is no doubt impossible to live without thought of the future; hope and vision can live nowhere else. But the only possible guarantee of the future is responsible behavior in the present."

The "stewardship" point of view integrates these notions in its recognition of the necessity to properly utilize or manage our planet in a way which maintains the continued "health" and availability of our resources and, thereby, ensures the long-term survival of both natural and human systems.

"The [people] of a society has a fundamental responsibility, which we have neglected, for stewardship -- particularly for the biophysical systems that support our society. It is the only organ of society which can protect those systems and protect future citizens of the society from loss of their needed resources through the profiteering of present citizens. The [people's] fundamental obligation in this area is to prevent deterioration in the support capacities of the biophysical systems, maintain in stable and sound fashion their ongoing capabilities, and whenever possible extend those capabilities in terms of quality as well as quantity. Present and past governments, and those who have profited from their actions, must be accountable for loss to present and future citizens and to the biophysical systems themselves from their actions."[10]

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[10] Tom Bender. Sharing Smaller Pies, p. 13.

ACTIVITIES

FACILITATING NOTES

1. Do Activity I as a whole group discussion.
2. For Activity II, divide up the reading assignments (i.e., Berry, Stone, Dasmann) among the teachers. When the individual readings and questions have been completed, you should hold a group discussion to present and share the different "worldviews" presented regarding the use and abuse of the natural environment and its resources.
3. Do Activity III as a whole group discussion and work towards a consensus of opinion regarding a "stewardship worldview" to using environmental resources.

ACTIVITY I

OBJECTIVE: (e) To be familiar with some attitudes and values which help to promote abuses and misuses of natural resources.

TO DO: Considering the various views presented under land abuse attitudes (p. 50), discuss the following "popularized" attitudes in terms of how they might contribute to or influence the abuse or misuse of our natural resources.

- "Bigger is better."
- "Progress is our most important product."

ACTIVITY II

OBJECTIVE: (f) To understand the attitudes and values that contribute to the evolution of a stewardship worldview.

TO DO:

1. Each group member completes one of the following readings and the questions associated with that reading.
2. Based on this reading each person offers the group a brief characterization of the attitudes and values that contribute to a Stewardship Worldview.
3. The group discusses how a Stewardship Worldview promotes effective long-term management of environmental resources.

READING I: Berry, Wendell, "Exploitation and Nurture," CoEvolution Quarterly, Spring, 1977, pp. 57-71.

TO DO:

1. Summarize the characteristics of a "model exploiter" and a "model nurturer" as described by Wendell Berry. Include the standards, goals, and attitudes of each.

Model Exploiter	Model Nurturer

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2. Why would it be difficult for some conservation-minded citizens to practice a "Kindly Use" philosophy toward our resources?

3. What are some reasons that wilderness preservation is the ethical backbone of any conservation effort?

READING II: Stone, Christopher D. Should Trees Have Standing? Toward Legal Rights for Natural Objects, 1974, pp. 27-111. (paperback)

or

Stone, Christopher D. Should Trees Have Standing? Toward Legal Rights for Natural Objects, 1974, pp. 10-54. (hardback)

TO DO:

1. Discuss Stone's "serious proposal to give legal rights to 'natural objects' in the environment" in terms of the following:

   The legal-operational aspects: how can we legislate "Kindly Use"? Consider:

   - How common law defines "rights" to environmental objects such as streams or trees
   - How a "guardianship approach" would secure rights for natural objects
   - Ways to measure environmental damage

   The psychic and socio-psychic aspects: how can we value "Kindly Use"? Consider the implications of conferring rights on the environment in terms of:

   - "Material comforts" associated with our present high-energy society
   - "Human rights" in a society based on the "historical growth" scenario
   - The concept of "spaceship earth"

2. What are the implications of legal rights for natural objects in terms of the following:

   - "Kindly Use" of resources
   - Energy-conserving life-style
   - Individual responsibility
   - Equity

READING III: Dasmann, Raymond F. Planet in Peril, 1972, pp. 127-143.

McHarg, Ian. Design with Nature, 1971, pp. 23-29.

Miller, Jr., G. Tyler. Living in the Environment: Concepts, Problems, and Alternatives, 1975, pp. 28-30.

TO DO: On the basis of these authors' views, describe and contrast the characteristics of a "man versus nature" and a "man in nature" orientation.

STEWARDSHIP WORLDVIEW

SUMMARY

Based on the previous readings and answers to the Activity questions, characterize a Stewardship Worldview approach to environmental resources with respect to the following:

"Finite Pie"

Equity

Nurture

"Kindly Use"

Use of Tools/Technology

Individual and Collective Responsibility

"Future is Now"

Centralization/Decentralization of control over resources

SECTION 3

RESOURCES

Clapham, W. B., Jr. Natural Ecosystems, Riverside, NJ: Macmillan Publishers and Co., Inc., 1973.

Dasmann, Raymond F. Planet in Peril, New York: World Publishing Co., 1972.

Greenwood, N., and Edwards, J. M. B. Human Environments and Natural Systems, North Scituate, MA: Duxbury Press, 1973.

Miller, Jr., G. Tyler. Living in the Environment: Concepts, Problems, and Alternatives, Belmont, CA: Wadsworth Publishing Co., Inc., 1975.

Odum, Howard T. Environment, Power, and Society, New York: Wiley-Interscience, 1971.

Odum, Howard T., and Odum, Elizabeth C. Energy Basis for Man and Nature, New York: McGraw-Hill Book Co., 1976.

Russwurm, Lorne H., and Sommerville, Edward (eds.). Man's Natural Environment: A Systems Approach, North Scituate, MA: Duxbury Press, 1974.

Sutton, David B., and Harmon, N. Paul. Ecology: Selected Concepts, New York: John Wiley & Sons, Inc., 1973.

SECTION 3

ECOSYSTEM STRUCTURE AND PROCESSES

Upon Completing this section, you should:

(g) Understand the major cycles and processes of our biophysical life support system.

(h) Understand energy flow patterns in systems and how they can be depicted.

(i) Understand the principles of energetics.

(j) Understand some important principles of ecosystem development and equilibrium.

This section describes the structure and functions of the natural systems and cycles on which we depend. It provides a knowledge base for appreciating the value of a stewardship approach to nature and for understanding the capacities and finite resource capabilities of natural ecosystems.

Intrinsic to an appreciation of a stewardship approach to protecting the natural environment and managing its resources is an understanding of natural ecosystems--the major components and energy processes, and the basis upon which natural ecosystems develop and maintain their stability.

a. Our Life Support System--the Biosphere

BIOSPHERE

LITHOSPHERE

HYDROSPHERE

ATMOSPHERE

The spherical shell of life for this planet, the biosphere, comprises an area having an approximate thickness of only nine miles. The biosphere extends from the surface layer of soil, minerals, and rocks (lithosphere), the oceans, lakes, and streams (hydrosphere) to a layer of gases and vapors (atmosphere) about seven miles high. The biosphere is a natural system at the planetary level. It contains all the elements necessary for organic life: solar energy, air, water, soil, heat, wind, and essential chemicals.

ECOSYSTEMS

BIOTIC

ABIOTIC

The biosphere can be visualized as a vast composite of diverse ecosystems. These ecosystems are self-sustaining natural systems with both living (biotic) and nonliving (abiotic) planetary resources. The nonliving components of the planetary ecosystem (nutrients, minerals, and inert materials) are contained within solid earth, water, and the atmosphere.

These, together with living organisms represent the total complex of factors operating within the ecosystem. Figure 2 below represents the interactions of the biotic and abiotic components in the natural ecosystem.

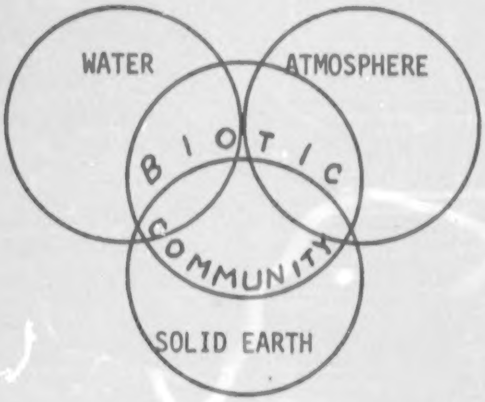

Figure 2.

Within the natural ecosystem several general types of ecosystems exist. For example: aquatic ecosystems include all predominantly waterborne life forms found in oceans, lakes, estuaries, ponds, rivers, coral reefs or swamps.

Terrestrial ecosystems exist on land; these include the majority of natural systems known to us: animals, humans, forests, grasslands, deserts, etc.

Atmospheric ecosystems support life forms that organize and spend their life cycles predominantly in the atmosphere.

Each natural ecosystem can be divided into smaller units. The usual levels of organization for ecosystems are:

Ecosystems
↑
Communities
↑
Populations
↑
Organisms

POPULATION

COMMUNITY

A group of individual organisms of the same kind is called a population. Different populations living together in a particular area create a natural community. The ecosystem includes: all of the populations or biotic communities; all elements of the nonliving environment; and all the interactions that bind the living and nonliving components together into a self-sustaining system.

b. Energy Flows and Energetics in Natural Systems

A familiarity with principles that are common to all systems is helpful when dealing with the structure and processes of complex ecosystems. As with any system, an ecosystem has boundaries, inputs and outputs, and interactions between its components. It is particularly important for an understanding of ecosystem functions to examine these systems in terms of: (1) energy flows and material cycling, (2) the principles of energetics, and (3) energy flow diagrams. The following discussion illustrates how these operate.

(1) Energy Flow and Cycling

ENERGY FLOW

Matter and energy are constantly flowing through an ecosystem. The pattern of this flow is the key to understanding the actual and potential "work" of the ecosystem. One type or pattern of energy flow is the linear input and output movement between systems or components of a system.

The nature of this energy flow pattern is unidirectional and includes substantial energy losses. It also carefully regulates itself, storing and cycling its nutrients into sediments for further use.

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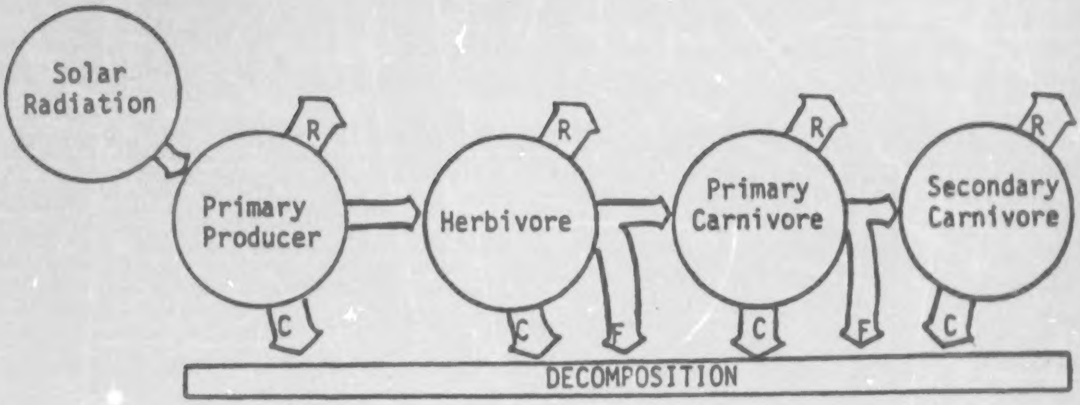
Figure 3. The Food Chain



Food Chain Showing Inputs and Energy Losses

R=respiration F=feces C=decay

The food chain shown in Figure 3. is an example of this input to output flow of energy and material through the entire biotic community. The above diagram illustrates this pattern, indicating the transfers of energy from one level to the next and the energy lost through respiration or decay at each stage of the transfer.

In this type of energy flow pattern, the energy losses, especially through respiration, are considerable. The "life" of this chain depends on the ability of each species to assimilate enough energy to offset losses and to continue to grow and function. The limit is reached when the lifeforms can no longer balance their energy expenditures with sufficient energy intake.

The organic wastes from this food chain are not lost to the ecosystem as a whole. They provide an energy source for a variety of soil organisms which degrade, or break down this waste into simpler compounds, carbon dioxide, water, and humus for the soil. This process releases nutrient elements such as nitrogen, phosphorous, and sulfur into the environment to be reutilized by living organisms. It also promotes the storages of organic materials in the form of sediments. These sediments offer a permanent storage place for fixed carbon which is the source of our fossil fuels, and they also provide the mechanism for maintaining the oxygen in the earth's atmosphere.[2]

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[2] Clapham, Natural Ecosystems, p. 36.

Energy flows in one direction through an ecosystem, but some mineral nutrients are cycled, that is, they are reused again and again. An example of this natural system process is the continuous cycling of the chemicals necessary for life throughout the biosphere. Chemicals such as carbon, oxygen, hydrogen, nitrogen, sulfur, and phosphorus cannot be degraded. Furthermore, the supply of these elements is finite. "Therefore, the flow of these elements through the ecosystem must be cyclical, with matter constantly being reused."[3]

CYCLING

This flow of energy and cycling of materials through an ecosystem underscores the interrelatedness of the constituent parts of the system. It also suggests the need to maintain a dynamic balance between these ecosystems and their environment. Any interruption or alteration to this natural flow of energy and nutrients can be compensated for by the existing natural feedback mechanisms or, if of sufficient magnitude, it may destroy or disrupt the total balance in an ecosystem.

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[3] Ibid, p. 38. A detailed discussion of these cycles in nature can be found in Clapham, pp. 38ff.

(2) Principles of Energetics

There are three important laws or principles of energetics fundamental to the flow of energy in both natural and human systems.

(a) Law of Energy Conservation

According to the first law of thermodynamics, also known as the law of energy conservation, energy is a finite resource and can neither be created nor destroyed. Energy is merely transformed from one of its forms such as heat, light, mechanical, electrical, or chemical energy to another form.[4]

> The energy entering a system must be accounted for either as being stored there or as flowing out.

(b) Law of Energy Degradation

The second principle referred to as the Law of Energy Degradation (also called the Entropy Law) states that in all processes, some of the energy will be changed into a less concentrated form such as the heat of automobile exhaust or thermal power plant discharge.

> "In all processes some of the energy loses its ability to do work and is degraded in quality."[5]

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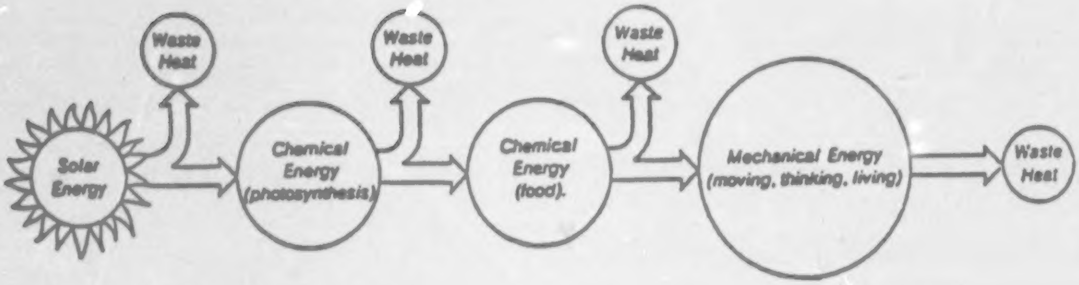
[4] G. Tyler Miller, Jr., Living in the Environment: Concepts, Problems, and Alternatives. Belmont, CA: Wadsworth Publishing Co., Inc., 1975.

[5] Odum and Odum, Energy Basis for Man and Nature, p. 38.

As illustrated in the diagram below (Figure 4.), all energy transformations are inefficient and add waste heat which is essentially useless energy to the environment.[6]

Figure 4. Process of Energy Degradation


Waste Heat
Waste Heat
Waste Heat
Solar Energy
Chemical Energy (photosynthesis)
Chemical Energy (food).
Mechanical Energy (moving, thinking, living)
Waste Heat

This means, among other things, that more energy must be constantly expended to maintain order and prevent depreciation.

This law of energy degradation also recognizes the increasing disorder or randomness inherent in any system and its surroundings. This entropic tendency determines the ultimate limit of what we can and cannot do. It tells us, in fact:

> "...that maintaining order in the form of life always increases disorder in the surroundings. It also tells us that as we try to support more and more humans at higher levels of energy and resource consumption, the amount of disorder in our life-support system will automatically increase."[7]

The two laws of energetics imply that it should be possible to account for all energy that occurs in ecological systems (that is, where it comes from and where it goes) and that as energy flows through ecological systems, less and less of it will be available to do work at each successive step.[8]

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[6] Miller, Living in the Environment, p. 37.

[7] Ibid, p. 36.

[8] Sutton, D. B. and Harmon, N. P., Ecology: Selected Concepts, 1973, p. 40.

(c) Maximum Power Principle

The maximum power principle explains how systems survive by organizing themselves to utilize the available energy resources.

> "That system survives which gets most energy and uses energy most effectively in competition with other systems."[9]

COMPETITION

This principle has the potential to predict what characteristics a system should have in order to compete successfully with neighboring systems for available resources. It also indicates that these competitive strategies must in fact change with the external energy conditions. To "get more energy" or develop more power inflow, for example, a system in an apparently abundant environment might:

- develop storages of high-quality energy
- use storages to increase energy flow (positive feedback)[10]
- use storages as a control mechanism to keep the system stable: inflows balance outflows (negative feedback)[11]
- recycle materials as needed.

COOPERATION

To "get more energy" when the system is in an apparently resource limited environment, different criteria come into play. In a limited or uncertain environment, system stability becomes important and competitive strategies are not helpful. Cooperation becomes favorable as a strategy for increasing the effectiveness of energy use through a programmed sharing of resources. In this situation a system might:

- develop symbiotic relationships with neighboring systems
- increase overall system efficiency of energy use (conservation)
- maintain stability by encouraging diversity and discouraging monotony
- develop feedback pathways to recycle resources.

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[9] Odum and Odum, Energy Basis for Man and Nature, p. 39.

[10] Positive feedback causes a system to change; to move away from a fixed point.

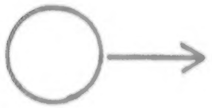
[11] Negative feedback causes a system to avoid change; to maintain a fixed point by correcting for deviations or fluctuations.

(3) Energy Flow Diagrams

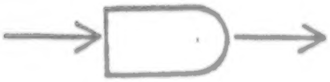
A set of simple diagrammatic symbols can be useful as a standardized means of visualizing energy flow and depicting the behavior of whole energy systems. A diagram composed of such symbols can be used to model the interactions of resources and energy flows of any real life system.

A set of energy-oriented symbols has been developed by H. T. Odum to be used as a more precise method for diagramming the interactions of man and nature.[12] These symbols are based on the most common operations found in all systems that process resources and utilize energy.

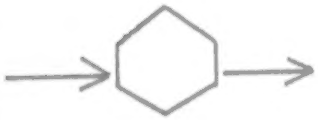
The symbols[13] are representative of the following energy processes:



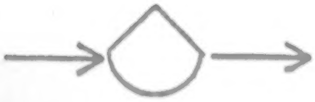
Sources of direct or stored energy from outside a system (e.g., sun, river, geysers, wind, fossil fuels)



Production subsystem involving photosynthesis activities (e.g., farms, forests, coral reefs, biological communities of streams)



Self-maintaining consumer unit using energy produced elsewhere (e.g., people, animals, households, cities)



Energy storages within a system or subsystem (e.g., water tank, oil tank, library, manufactured structures)

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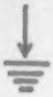
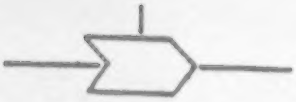
[12] Odum, Howard T., and Odum, Elisabeth C., Energy Basis for Man and Nature, New York: McGraw-Hill Book Co., 1976.

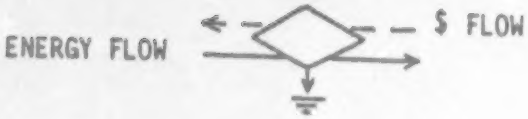
[13] See Odum, Howard T., Environment, Power, and Society, New York: Wiley-Interscience, 1971, for more detailed set of symbols.



Energy sinks (e.g., heat losses, wastes, degradations, dilutions)



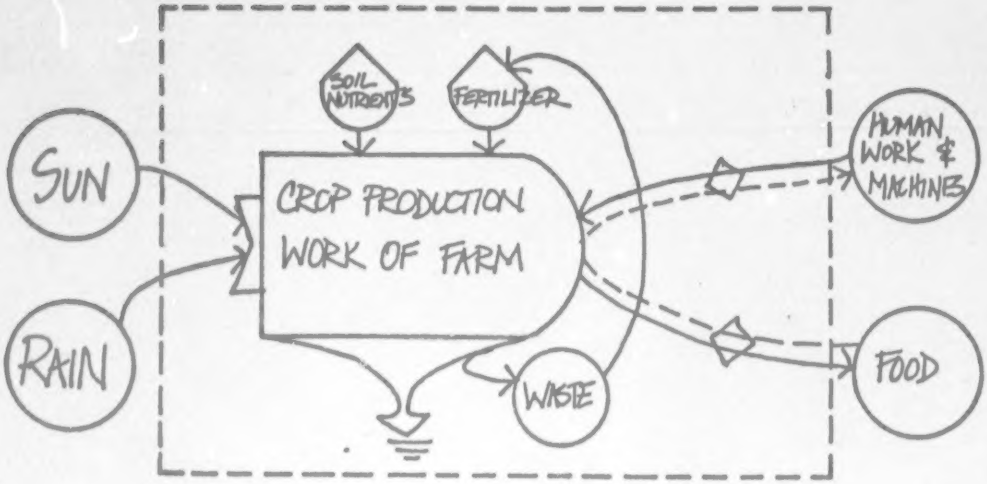
Interactions of energies flowing along pathways (e.g., in farming: interaction of sunlight, H_2O, soil, and machinery to produce food)



Flow of money in one direction to pay for energy flowing in the other direction.

The following example (Figure 5) uses these symbols to show some processes and energy flows within a farm system:

Figure 5.


SUN
RAIN
SOIL NUTRIENTS
FERTILIZER
CROP PRODUCTION WORK OF FARM
HUMAN WORK & MACHINES
FOOD
WASTE

Energy input in the form of sun, rain, human work, and machinery (for planting, nurturing, harvesting, and processing the crops) flow into or enter the system. The human work and machinery are purchased. The sunlight and rain are provided free by nature. Nutrients stored in the soil and needed for crop production are also utilized by the system. The end products of crop production are the foodstuffs produced and offered for sale--part of the profits here are used to purchase more labor and machinery. Then agricultural waste materials need to be disposed of or recycled as fertilizer. A by-product of this production work is the energy lost in the form of heat at each stage of the crop production process.

c. Ecosystem Growth and Development

All natural systems are dynamic, being constantly engaged either in a state of growth and accumulation or in a state of balancing inputs and outputs in order to maintain structure and stability. The first of these states, growth and accumulation, can be examined through the system's characteristics and processes of succession, climax, diversity, and simplicity.

SUCCESSION

Ecosystems change and grow through a process known as succession in which life forms (plants and animals) are continually succeeded or replaced with subsequent life forms over a long period of time until a more or less steady state relationship is reached by the life forms with their environment. This is known as climax condition. The development from initial life forms (early succession) to subsequent life forms (middle succession) to mature life forms (climax) occurs through competition for available resources (food and nutrients, sunlight, water, suitable temperatures, etc.). As the limits to the supply or abundance of these resources are reached, rival life forms enter a more steady state of cooperation in sharing these resources. This steady state of cooperation is characteristic of a climax ecosystem.

CLIMAX

DIVERSITY

Where the resources are abundant, a great diversity of life forms will evolve which can utilize the full range of these resources. Where resources are scarce, however, only more simplified ecosystems (with fewer types of life forms) are able to be sustained.

SIMPLICITY

Ecosystems marked by simplicity tend to be much more susceptible to disruptions or periodic fluctuations in population since there are fewer species and, thus, fewer options available in the food chain. In an ecosystem marked by diversity, fluctuations in the size or population of any given species has relatively little impact on the ecosystem as a whole.

d. Ecosystem Stability and Equilibrium

> "We often view ecosystems as systems in dynamic equilibrium with their environment: that is, as systems that do not change, on the average, because the import and outflow of any parameter balance one another."[14]

Ecosystems that are in dynamic equilibrium may appear not to change very much, but the mechanics for achieving this kind of balance involve constant adjustments on the part of the ecosystem as it balances its surpluses with its deficits. One of the fundamental traits of natural system processes is the way in which these inbalances are overcome. The ability of natural systems to adapt, and to constantly adjust to changes in the environment is the result of long-term evolutionary processes.

Stability in an ecosystem implies persistence of its structure over time. Change occurs in the system, but the system's structure remains recognizable. The equilibrium, or balance of the system, is maintained, not as the result of sameness, but as the result of dynamic change and adaptation.

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[14] Clapham, Natural Ecosystems, p. 17.

> "If a system is to continue to exist it must maintain some kind of equilibrium; gain and loss must balance around some mean figure. There are limits to the amount of change that a system can tolerate. Because such tolerance limits exist, stabilizing factors that go into operation when the processes change place strains on a system. Hence equilibrium can be understood as the interaction of the process of change and the processes of stability."[15]

While the growth and development of ecosystems depend on their ability to capture and use energy (maximum power principle) and the abundance of resources, the stability of ecosystems depends also on their diversity (less diverse ecosystems are more susceptible to disruption) and on the presence of homeostatic or feedback mechanisms. One of the stabilizing agents of this dynamic equilibrium process is the system's natural feedback mechanism.

FEEDBACK

Any disturbance causing a system to return to its original state, is regarded as negative feedback. However, any disturbance generating further change or deviation from its original state, is regarded as positive feedback. Negative feedback is responsible for system maintenance; it regulates the system so that it will maintain its status quo. Positive feedback, instead of counteracting change, reinforces it. Positive feedback strengthens the thrust of the input. Harmful positive feedback is popularly called a "vicious circle" or the "snowballing effect;"

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[15] Russwurm, Lorne H., and Sommerville, Edward, eds., Man's Natural Environment: A Systems Approach, North Scituate, MA: Duxbury Press, 1974, p. 11.

changes occur in the same direction at a compounding rate.[16]

STABILITY

The implications of having such runaway growth in an ecosystem are clear: without the dynamic regulation of negative feedback the system will expand beyond the limits of the ecosystem's environment and the stability of the ecosystem will be threatened. As the amount of structure increases, energy costs to maintain that structure increase even faster. Stability then, not overt growth, appears to be the most successful strategy of natural systems.

Thus, in interacting with the natural systems, it is necessary to maintain a proper respect for the often delicate mechanisms which keep these systems in equilibrium and functioning at peak efficiency. A knowledge of the workings of the ecosystem as a whole is necessary as a prelude to environmental decision-making with respect to the natural systems.

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[16] Ibid., p. 14.

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ACTIVITIES

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FACILITATING NOTES

1. You will need to make sufficient copies of the readings for Activities I-IV to avoid a great deal of wasted time waiting for teachers to read and pass them along.

2. Activity II should be done as a whole group activity. The other activities, if time is short, can be divided up amongst the teachers and completed individually, as long as the information or findings are shared subsequently in a whole group discussion.

3. Regarding Activity II, item #4, in developing your energy diagram, use Odum and Odum and Figure 5. (pp. 83) of the module for examples of how to depict a system in energy flow terms.

ACTIVITY 1

OBJECTIVE: (g) To understand the major cycles and processes of our biophysical life support system.

READINGS: Dasmann, Raymond F., Planet in Peril, 1972, Chapter 2, "The Biosphere," pp. 41-90.

Greenwood, Ned, and Edwards, J.M.B., Human Environments and Natural Systems, 1973, Chapter 3, "The Ecological Basis," pp. 40-67.

TO DO: Make a chart or a diagram which describes the major life support systems of the earth (atmosphere, hydrosphere, lithosphere) in terms of their:

- components (e.g., oceans, lakes, mountains, etc.)
- characteristics (e.g., precipitation, runoff, succession, diversity, energy flow patterns, etc.)
- interrelationships or interactions (e.g., hydrologic cycles, chemical and mineral cycles, etc.).

Make sure all are at the same level of detail. Look closely at each producer unit to make sure all inputs and outputs are included.

4. Arrange energy symbols into a diagram. Check for "reality" and completeness by making sure you have represented all necessary energies: materials, heat sinks, and wastes, etc.

A Suggestion...

In developing your energy diagram, it is important to consider the implications of energy flows through it. This requires more than simply drawing lines between the elements. Every line represents a process, and every process has a direction.

OBJECTIVE: (h) To understand energy flow patterns in systems, and show how they can be depicted.

READING: Odum, Howard T., and Odum, Elisabeth C. Energy Basis for Man and Nature, 1976, Chapter 1, pp. 16-23.

TO DO: Using energy symbols construct an energy flow diagram of a natural ecosystem.

1. Choose a specific system to diagram--one that includes producers and consumers and shows energy flows and movement of resources (e.g., pond, meadow, milk production in a cow.)
2. List 10-15 of the most important variables of the system, including components, inputs, and outputs (nouns) (e.g., grass, nutrients, fish), and processes (verbs) (e.g., eating, photosynthesizing).
3. Arrange these variables in the following chart:

	inputs or sources	storages	consumers	producers	outputs
EXAMPLE	SUN RAIN	FERTILIZER	COWS	GRASS	DAIRY PRODUCTS

OBJECTIVE: (i) To understand the principles of energetics.

READING: Odum, Howard T., and Odum, Elisabeth C. Energy Basis for Man and Nature, 1976, Chapter 3, pp. 37-48.

TO DO:

1. For each of the processes below, briefly describe how potential energy is "degraded". That is, describe the forms of energy inputs, energy outputs, and energy losses: e.g., electrical energy (input) → mechanical energy (output) and ↓ heat (energy loss) in the form of exhaust.

   - photosynthesis
   - food production
   - automobile operation
   - electric blender

2. Do the above processes tend toward order or disorder? How?

3. Give an example of a natural system maximizing energy for survival.

OBJECTIVE: (j) To understand some important principles of ecosystem development and equilibrium.

READINGS: In addition to Dasmann, Chapter 2 and Greenwood and Edwards, Chapter 3, (Activity I), read the following:

Odum, Howard T., and Odum, Elisabeth C. Energy Basis for Man and Nature, 1976, and Chapter 7, "Flows of Energy in in Ecological Systems," pp. 93-113.

ADDITIONAL READINGS:

- *Russwurm, Lorne H. and Sommerville, Edward (eds.), Man's Natural Environment: A Systems Approach, 1974, Chapter 1, "A Systems Approach to the Natural Environment," L. H. Russwurm.*
- *Miller, Jr., G. Tyler. Living in the Environment: Concepts, Problems, and Alternatives, 1975, Chapters 3, 4, and 5.*

TO DO: Describe a natural ecosystem life cycle (e.g., forest or woodland system) in terms of the following principles:

- Succession
- Climax
- Diversity
- Stability (equilibrium)
- Feedback

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SECTION 4

RESOURCES

Bishop, A. B., et al. Carrying Capacity in Regional Environmental Management, Washington, DC: Environmental Protection Agency, GrantNo. 802444, Feb., 1974.

Forrester, Jay W. Urban Dynamics, Cambridge, MA: The M.I.T. Press, 1969.

Hardin, Garrett. "The Cybernetics of Competition: a Biologist's View of Society," Perspectives in Biology and Medicine, Vol. 7, 1963.

Holling, C. S. and Goldberg, M. A. "Ecology and Planning," Journal of American Institute of Planners, Vol. 37 (4), 1971.

Holling, C. S. and Orlans, G. "Toward an Urban Ecology," Bulletin of the Ecological Society of America, Vol. 52 (2), 1971.

Koenig, H. E. and Tummala, R. G. "Principles of Ecosystem Design and Development," I.E.E.E. Transactions on Systems, Man, and Cybernetics, Vol. 2 (4), 1972.

League of Women Voters of Florida Education Fund. Local Government: A Changing Role, Coral Gables, FL, 1975.

McHarg, Ian. Design with Nature, Garden City, NY: Doubleday and Co., Inc., 1971.

Miller, Jr., G. Tyler. Living in the Environment: Concepts, Problems, and Alternatives, Belmont, CA: Wadsworth Publishing Co., Inc., 1975.

Perloff, H. S. "A Framework for Dealing With the Urban Environment," in The Quality of the Urban Environment, H. S. Perloff (ed.), Baltimore: Johns Hopkins Press, 1969.

Wenner, Tettie M. One Environment Under Law, Pacific Palisades, CA: Goodyear Publishing Co., Inc., 1976.

SECTION 4

NATURAL SYSTEM ECOLOGY AND CARRYING CAPACITY

Upon completing this section you should:

(k) Understand some natural system properties essential to the notion of carrying capacity.

(l) Be familiar with the types of natural system resources and their relationship to an ecosystem's carrying capacity.

(m) Be familiar with the major types of landforms and the "free work" these landforms provide.

This section introduces the concept of carrying capacity from the perspective of ecosystem properties, resources, and functions. It provides an understanding of what natural resources are and what they can "do", which becomes the basis for examining the conflicts between natural and human systems in Section 5.

CONSTRAINTS

The natural environment represents a *constraint* on the human sector...as far as the rates at which the environment can produce raw materials and assimilate or absorb wastes. The rates and capacities of the natural environment for production and assimilation are fixed by evolutionary processes and are not responsive to changing human demands.

RIGIDITY

The term "constraint" implies a certain *rigidity* of the natural environment...which has the capability of producing a certain output flow of products and assimilating a certain input flow of wastes. These input and output processes can take place without disrupting the integrity of the natural environment provided that its inherent capabilities or capacities are not exceeded. The magnitude of these capabilities depends on the environmental conditions and the stage of ecosystem development or succession.[1]

INPUT AND OUTPUT

ELASTICITY

The *elasticity* of the natural environment is another aspect of the system to consider. Only here the question is how much can an ecosystem be manipulated without major change? Stresses imposed on some parts of an ecosystem have a shared effect on other parts of the system. Many stress-relieving cycles are built into natural ecosystems which, like other

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[1] Bishop, A. B., et al. *Carrying Capacity in Regional Environmental Management*, a final report submitted to the Environmental Protection Agency, Washington, D.C., Grant No. 802444, February, 1974, p. 7.

LE CHATELIER'S PRINCIPLE

systems, appear to follow Le Chatelier's principle, i.e., systems will tend to compensate for stress.[2]

There are limits, however, to how much stress an ecosystem can absorb and still be able to return to its

LIMITS

original condition. Constraints define these limits. When the human environment interacts with the natural environment the problem becomes one of recognizing and quantifying the constraints within which the natural system can absorb the stresses of urban, agricultural growth, and resource exploitation without incurring irreparable damage through loss of structure or equilibrium.

An ecosystem's capacity to accommodate human encroachment while resisting damage and maintaining its stability forms that ecosystem's carrying capacity.

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[2] Ibid, p. 8.

a. Ecosystem Properties and Carrying Capacity

If the concept of carrying capacity is to be useful it must help an "environmental manager" determine the impacts of various proposals on regional[3] environmental quality. To do this requires insight and an understanding of the behavior of natural systems and the ways the "health" of our environmental support systems can be measured and the time-dependent changes therein monitored.

In considering any ecosystem's (natural and human) carrying capacity, two distinctive properties stand out: stability and resistance.

STABILITY

- In describing stability, we use the example of the temperature regulation of warm-blooded animals used by Hardin (1963)[4] and Holling and Goldberg (1971)[5]:

> In man the temperature is close to 98.6°F. If through sickness or through dramatic change in external temperature, the body temperature begins to rise or fall, then negative feedback processes bring the

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[3] The region is generally considered to be the smallest unit in which an ecosystem and all its components are visible and therefore amenable to "whole-system" examination.

[4] Hardin, Garrett. "The cybernetics of competition: a biologist's view of society," Perspectives in Biology and Medicine, 1963, Vol. 7, p. 6

[5] Holling, C. S., and Goldberg, M. A. "Ecology and Planning," Journal of American Institute of Planners, 1971, Vol. 37 (4), p. 227.

> temperature back to the equilibrium level. But we note this regulation occurs only within limits. If the body temperature is forced too high--above 106°F., the excessive heat input defeats the regulation. The higher temperature increases metabolism which produces more heat, which produces higher temperature, and so on. The result is death.

Thus, the concept of stability in natural (and human) systems recognizes the existence of forces that tend to move the system towards an equilibrium state. Also, as was seen in the temperature example, stability is not identified as just a single equilibrium point, but as the range within which the temperature can be regulated. This fact gives rise to a second important property of an ecosystem--its resilience.

RESILIENCE

The concept of resilience describes the limits of an ecosystem's stability, or the point at which forces may disrupt the system and cause radical changes to occur. The types of forces are here classified in terms of pollution processes:[6]

- Nonpollution levels--where pollution input rates do not exceed the capacity of the ecosystem to handle or process the material. Thus, the pollution being dumped into a lake or stream, for example, is said to be within the processing or carrying capacity of the lake or stream.

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[6] Koenig, H. E. and Tummala, R. G. "Principles of Ecosystem Design and Development," I.E.E.E. Transactions on Systems, Man, and Cybernetics, 1972, Vol. 2 (4), p. 451.

- Reversible pollution--where the pollution input rates are such that the ecological state initially moves outside quality regions, but can eventually return once the pollution is removed or "neutralized."
- Nonreversible pollution--where the pollution input rates are so extreme that the ecological state eventually moves outside quality regions, and cannot return even by reduction or removal of the pollution material.

An additional and critical point here is that the stability of a natural (or human) system can also be broken down by the accumulative effect of a series of disturbances. With each successive disturbance, even though small, the system becomes less capable of absorbing or handling additional disturbances. In effect, then, the resilience of a system is dependent on its ability to withstand shocks or disturbances. This resilience concept is important in defining a system's carrying capacity in that it can be used to shift attention away from descriptions of "optimum," "maximum," or "equilibrium" systems behavior towards descriptions of systems behavior near delicate stability/instability boundary where environmental degradation is likely to begin. Holling and Orlans (1971) stress the need to understand "the complex nature of tradeoffs and limitations and options and resilience that characterize systems operating close to the carrying capacity of the environment."[7]

While it is not yet possible to quantify the resilience of a complex system,[8] the concept of systems resilience helps us to consider ecosystems' carrying capacity in terms of such things as (1) boundaries, thresholds, tolerances, and limits to (2) growth, reproduction, and resource use at (3) individual, community, or societal levels. It also helps us to consider triggering factors which, at a certain threshold, can set off a chain of events in an ecological system.

The task of defining and determining carrying capacity must incorporate an understanding and analysis of systems boundaries and processes. This realization is summarized by Holling and Goldberg as follows:

> It is this boundary oriented view of stability emerging from ecology that can serve as a conceptual framework for man's intervention into ecological systems. Such a framework changes the emphasis from maximizing the probability of success to minimizing the chance of disaster. It shifts the concentration from the forces that lead to convergence on equilibrium, to the forces that lead to

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[7] Holling, C. S. and Orlans, G. "Toward an Urban Ecology," Bulletin of the Ecological Society of America, 1971, Vol. 52 (2), p. 4.

[8] Bishop, et al., p. 24. See Jay W. Forrester, Urban Dynamics, Cambridge, Mass.: The M.I.T. Press, 1969, for work in this area.

divergence from a boundary. It shifts out interest from increased efficiency to the need for resilience. Most important, it focuses attention on causes, not symptoms. There is now, for example, growing concern for pollution, but the causes are not just the explosion of population and consumption, but also the implosion of the boundaries of stability.[9]

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[9] Holling and Goldberg, p. 224.

b. Natural System Resources

From the perspective of carrying capacity, rather than assuming the usual land, water, and air delineations, the description of natural systems resources might be elaborated along the lines suggested by Perloff:[10]

Ambient resources:	Air, water, open space, quiet and noise zones, sunlight exposure.
Spatial resources:	Underground space, available and transitional surface space, airways space.
Ecological resources:	Green plants, nongreen plants, animals.
Economic resources:	Raw materials (oil, iron, coal, zinc, copper, etc.) for production inputs, capital, labor.
Amenity resources:	Seashores, scenic areas, contiguous natural areas (mountains, deserts, lakes), open space.

RESOURCE RENEWABILITY

The quantity and quality of a resource are closely related to its characteristics of renewability or nonrenewability. Stock resources, such as mineral deposits, fossil fuels, and available land, are essentially fixed in quantity and in that sense are nonrenewable. The capacity of such resources for supporting urban systems, therefore, depends on rate of use or exploitation, the possibilities for salvage and recycling, and the development of substitutes. Naturally renewed resources (e.g., vegetation and animal growth) and flow resources (e.g., solar radiation and natural cycles for water and other elements) have renewable characteristics in which process rates determine the quantity and quality available in a given time period for human use. Obviously, the "capacity" of renewable resources depends on the care and efficiency of human's use of the resource without upsetting or destroying the natural processes which assure the resource availability.

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[10] Perloff, H.S. "A Framework For Dealing With The Urban Environment," in The Quality of the Urban Environment, H.S. Perloff (ed.), Baltimore, Md.: Johns Hopkins Press, 1969, pp. 3-25.

CARRYING CAPACITY CONCERNS FOR THE NATURAL SYSTEM

Although a logical starting point, it is difficult to define carrying capacity in terms of a finite resource base, since a resource is important only when transformed into an array of services. It does not represent a single service or output in most cases. The outputs and services of concern in terms of natural system carrying capacity are:

- the production of goods and services at levels consistent with society's desired quality of life, and
- the capacity to assimilate or absorb wastes

> into air, water, and land at levels which meet acceptable standards of environmental quality.[11]

In terms of assimilative capacities, many regions are apparently utilizing resources at levels far beyond what can be provided or sustained within the region itself. Thus, is born the necessity, in these regions, for importing large quantities of additional resources to support human populations and life-styles.

In addition, the unsolicited import and export of harmful waste residuals which accompanies the production and consumption of goods and services is of particular concern in analyzing an ecosystem's carrying capacity since these residuals have not been subject to satisfactory control through the incentives of the "free" market place.[12] Also, the problem of tradeoffs must be examined; the consumption of goods and services which augment our quality of life are the same activities which generate the wastes which reduce quality-of-life levels. The proper balance and tradeoffs between these in accommodating growth is one of the central issues in carrying capacity analysis.

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[11] Bishop, et al., p. 42.

[12] Wenner, Lettie M. One Environment Under Law, Pacific Palisades, Calif.: Goodyear Publishing Co., Inc., 1976, pp. 116-118.

In terms of the carrying capacity of natural systems, there usually appears to be a hierarchy of limiting factors[13] for any given region, although only a few resources actually effect constraints in limiting growth and development at any one point in time. These factors may be on the resource input (availability) side, the waste assimilation side, or else a small number of factors that act accumulatively and in combination to present limits to a region. These factors determine the natural system's resource limits for the region, and affect the distribution of animal and human population and activity across the region.

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[13] *Limiting factors* are environmental resource-related factors which physically and behaviorally limit growth, reproduction, and resource use.

c. Natural System Functions: The "Free-Work" of Nature

To complete our definition of carrying capacity (from a natural systems perspective), it is necessary to understand the discrete functions of ecosystem components and the limited extent to which humans can intrude on or manipulate them without disrupting their often delicate equilibrium and stability. In this respect, we realize that natural systems perform a great deal of "free work" beneficial to humankind (e.g., water catchment, water and air purification, etc.) which would be extremely costly to replicate or restore once interfered with. Furthermore, the type of "free work" performed directly relates to or determines the suitability of land (and water) forms for various human purposes or uses.

(1) Soils

TOPSOIL

The soil, its composition (e.g., clay, sand, gravel) and its arrangement or location (e.g., steep slopes, flatlands, wetlands, floodplains), breathes vital life into ecosystem processes and functions. The topsoil stores both natural and human-released nutrients which can self-renew through the life and death cycle of plants and trees.

SUBSOIL

The subsurface soil acts as a reservoir to store ground waters and as a foundation for trees and plants to prevent winds from toppling then. The subsoil, except in the case of recharge areas, (to be described shortly), acts as a barrier against the loss of ground water downward into

AQUIFERS

aquifers (defined on the following page), -- distributing water along its surface to adjacent land areas, lakes, and marshes. Improper development and drainage for urban or agricultural land uses causes serious damage to this system through erosion or through evaporation of ground water by the removal of shading vegetation.

(2) Vegetation

Natural vegetation systems (e.g., forests and woodlands, grasslands, swamps, etc.) provide food and shelter for wildlife, containment of soil against erosion, purification of air and water, and regeneration of soil through decay. These services are provided without the human system subsidies of management, fertilizers, pesticides, or water systems and require for their continued existence only protection from unlimited urban and agricultural expansion.

> As the urban areas of our state expand, it always takes land from the natural and agricultural areas. When our agricultural lands expand it normally consumes natural lands. The wastes from both urban and agricultural lands usually impacts our natural lands. The urban and agricultural system is always taking and the natural lands and vegetation are always giving. It is important to seek a balance between the stress caused by urbanization and the free resources of our natural lands to absorb this stress.[14]

(3) Aquifers

Aquifers are the large underground collection areas which hold, between layers of subsurface nonporous rock, annual rainfalls absorbed through highly porous areas in the soil. Since aquifers account for billions of gallons of trapped potable water, they represent a vital resource which can be tapped for agricultural and urban uses. At the same time, it is important that aquifers be protected from misuse through excessive drawdown (withdrawal) or contamination from soil and surface water pollution, either of which would cause the population centers to seek more expensive methods for obtaining a potable water supply.

DRAWDOWN

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[14] League of Women Voters of Florida Education Fund. Local Government: A Changing Role, Coral Gables, Fla., 1975, p. 20.

(4) Aquifer recharge areas

Any lands known as recharge areas are of prime importance to the continued supply of fresh water (to aquifers) since these land areas allow rain water to be absorbed into the earth. Special care must, therefore, be taken when developing the land around recharge areas.

> The methods by which the lands that are prime recharge areas are developed should be quite different from the development methods of other areas such as high run-off areas; yet development marches across these lines, in many places, with no recognition of the unique resource that lies beneath the surface.[15]

(5) Wetlands, Estuaries

ESTUARIES

WETLANDS

Estuaries are "thin, fragile zones along the coastlines where fresh streams and rivers meet and mix with salty oceans. Wetlands are the shallow slopes extending from where freshwater-saltwater intersect. They consist of a complex maze of marshes, bays, lagoons, tidal flats, and mangrove swamps.[16]

These systems nurture vast amounts of natural vegetation, harbor enormous variety of wildlife and marine species, hold water naturally to help prevent flooding, and provide large open spaces that result in "free" recreation areas. Because of their vast energy, wetlands and estuaries "are capable of processing substantial amounts of urban and agricultural wastes and through normal photosynthesis act as a cleaning agent for these wastes.[17]

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[15] Ibid, p. 24.

[16] Miller. Living in the Environment.

The destruction of these highly productive systems through draining, filling, and dredging into cheap lands for urban and agricultural uses results in the loss of a most valuable resource.

Now that we have considered the carrying capacity of natural system resources, and functions, we will extend our perspective in Section 5 to include the human system.

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[17] League of Woman Voters of Florida Education Fund, p. 26.

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ACTIVITIES

FACILITATING NOTES

1. Regarding Activity I, item #2, it is recommended that each teacher select a different system example to characterize the concepts of:

   CONSTRAINTS, RIGIDITY, ELASTICITY, STABILITY, AND RESILIENCE

2. Regarding Activity III, item #2, each teacher should rank order the landforms, then, in a group discussion, compare the individual rankings and try to arrive at a common, mutually agreed upon rank ordering.

OBJECTIVE: (k) To understand some natural system properties which are essential to the notion of carrying capacity.

TO DO: 1. In your own words (do not quote the text), define the following and give examples:

CONSTRAINTS

RIGIDITY

ELASTICITY

STABILITY

RESILIENCE

2. Select and describe the operations of one specific system (e.g., pond, meadow, household) in terms of each of the above properties.

OBJECTIVE: (1) Be familiar with the types of natural system resources and their relationship to an ecosystem's carrying capacity.

TO DO:

1. Classify the five types of natural systems resources in terms of their being essentially renewable or nonrenewable.
2. Illustrate the problem of "tradeoffs" when using resources to achieve a desired quality of life. That is, give some examples of "good" and "bad" outcomes resulting from the use of at least three resources (e.g., coal, oil, trees, land, etc.).

OBJECTIVES: (m) To be familiar with the major types of landforms and the "free work" these landforms provide.

READING: McHarg, Ian. Design with Nature, 1971, pp. 55-62.

TO DO: Assume this scenario: You are given the task of planning a new community in an undeveloped area which resembles that illustrated in "WATER FEATURES" (p. 59) and "LAND FEATURES" (p. 60) of McHarg. You decide to begin by assessing the physical characteristics of the area. To do this you will:

1. Develop a chart summarizing the "free work" of various landforms (i.e., marshes, floodplains, aquifers, aquifer recharge areas, steep lands, forests and woodlands, prime agricultural lands).
2. Next, rank order these landforms in terms of their value to you for development. Use a scale of 1-7 where (1) represents landforms you are least likely or willing to develop and (7) represents landforms you are most likely to develop. Base your decisions on their value to you in terms of the "free work" they perform and their degree of intolerance to human use.

SECTION 5

RESOURCES

Bahr, T.G., Cole, A. and Stevens, H.K. *Recycling and Ecosystems Response to Water Manipulation*. Arlington, VA: U.S. National Water Commission, 1972.

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SECTION 5

CARRYING CAPACITY AND THE HUMAN SYSTEM

Upon completing this section you should:

(n) Be familiar with three aspects of pollution which arise from human system conflicts with the natural system.

(o) Appreciate the importance of considering tradeoffs between our desires for quality of life and the resource capabilities of our natural environment.

(p) Be familiar with the types of human system resources, their functions, and their interrelationship with natural system resources.

This section broadens the notion of carrying capacity (introduced in section 4) to include the human system and elaborates upon the management of environmental resources.

NATURAL SYSTEMS ORIENTED DEFINITION OF CARRYING CAPACITY

Up to this point, the concept of carrying capacity has mainly been used and applied in terms of natural or ecological systems. The notion of an upper boundary on population is frequently referred to as a tool for managing natural communities or ecosystems. Generally, the upper bound on the population density of a particular species is set as the maximum population density which can be supported by a given environment (habitat, ecosystem) without degradation.[1] Since many of the difficult problems of environmental management arise, however, in an urban-regional context, the concept of carrying capacity must be viewed in a larger setting where urban systems interface with and are a part of natural systems.

In the critical interrelationships between human and economic activities, changes effect both our resource base and the environment. The capacity to accommodate such change is realized by what we refer to as the "carrying capacity" a term which includes not only the natural system but also the realm of human activity.

Rather than establishing a single fixed number as a "population carrying capacity," it is essential to concern ourselves with a number of resource limits and environmental factors that may act as constraints or inhibiting forces in the dynamic interaction of population growth, related socio-economic activity, the resource base, and the environment as an assimilator of waste by-products.

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[1] Dasmann, Planet in Peril, p. 78; Odum and Odum, p. 132.

Our attention, therefore, should be directed toward viewing the regional environment as a large support system for numerous, interdependent, and frequently competing activities... where the carrying capacity is determined *by the desired environmental quality levels.* These levels are themselves circumscribed by a wide variety of political /institutional, physical/biological, and social/cultural constraints.

a. Growth and the Human Environment

The basic goals underlying the structure of the human environment are growth oriented. Humankind's traditional manipulation of the environment, its use of resources, its individual and collective expectations, and the very nature of its institutional structures all assume and often require growth.[2] This growth, as reflected by increasing flow rates of materials and energies, places ever-increasing demands on the production and assimilation capabilities of our natural environmental resources.

Examples of ecological problems stemming from our growing demands for resources are reflected in both the urban and agricultural systems:

- Example #1. Although humankind has achieved very high productivity in agricultural systems, the efficiency of production is a result of a tremendous energy cost required in order to "stabilize"[3] and control the system. Two expensive ways in which humankind has asserted its its own idea of stability are through irrigation to stabilize the effects of periodic drought and application of pesticides to stabilize pest outbreaks. Each of these, however, has been only partially successful.[4]

  Other energy and environmental costs include not only direct costs such as supplying nutrients to the soil and making farm machinery, but also indirect or unanticipated costs such as depletion of groundwater resources at a greater rate than they are being replenished or accelerating the flow of nutrients through crops with potential costs to future generations due to an increase in oxygen-consuming organisms.[5]

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[2] See Berry, Foin, McHarg, Miller, or Olson and Landsberg to name only a few authors addressing the problem of growth.

[3] Often what appears to be "stable" for shorter term human needs may, in fact, be unstable or disruptive to natural systems in the long run.

[4] See appropriate sections in Dasmann, Greenwood and Edwards, Miller and E.P. Odum for discussions of irrigation and pesticides.

- Example #2. Although the urban industrial system provides some nutrients to ecosystems, stimulating their productivities, the toxic by-products of industrialization (heavy metals, various organic compounds, acids, radioisotopes, etc.) usually inhibit productivities and limit diversity in natural systems.[6] Urbanization also tends to concentrate wastes in relatively restricted parts of the ecosystem. Although these wastes are eventually dispersed throughout the ecosystem and ecosphere over time, immediate concentrations are often dangerous, and such localized concentrations give warning of what might happen to all resources in the future if present rates of waste disposal are continued.[7]

Virtually every urban center and natural ecosystem faces the problems of accommodating some degree of future growth and development. The evolution of our current demographic pattern in the United States is the result of powerful economic and resource factors, such as ready supplies of raw materials and water, cheap power, and cheap transportation (e.g. via coastal areas, large rivers, or the Great Lakes).[8]

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[5] See Dasmann, p. 120; Miller, pp. E108-E117; Odum & Odum, pp. 103-104.

[6] E. P. Odum, pp 151-152.

[7] See appropriate sections in Dasmann, Greenwood & Edwards, Miller, E.P. Odum, and others for discussions of waste disposal effects.

[8] Bahr, T.G., Cole, A., and Stevens, H.K. Recycling and Ecosystem Response to Water Manipulation, Arlington, VA: U.S. National Water Commission, 1972.

b. Economic Activities, Social Values, and Natural Systems

Economists aptly describe the problems arising out of the conflict in the progression or evolution of natural and human systems.[9] The manifestations of this conflict appear in widely varying aspects that have been labeled "pollution." The problem of pollution arises out of congestion and wastes (both of these relate to economic activity) plus social values or goals.

(1) Congestion is a problem that natural and human resources have in common. Bower (1971) describes this for ecological systems as follows:

> "In a low-density or economically undeveloped setting, an additional user of the natural environment may well impose essentially no cost on other users. As the density of development and the level of output increase, in the face of finite environmental resources, each additional user will impose additional costs associated with congestion on other users. This condition is termed an "externality" by econcomists--that is the additional user does not take into account the costs he imposed on others in his decision to use a common property resource. Because there are no prices on the services rendered by the environmental media and since they cannot be exchanged between buyers and sellers in a market context, the price mechanism in a market economy is not effective in limiting the use of environmental resources."[10]

The failure to consider the finite assimilative capacity of the natural environment leads to excessive use or congestion of natural systems. Obvious parallels are present within human systems particularly with regard to public distribution/transportation resources such as freeway congestion at peak hours.

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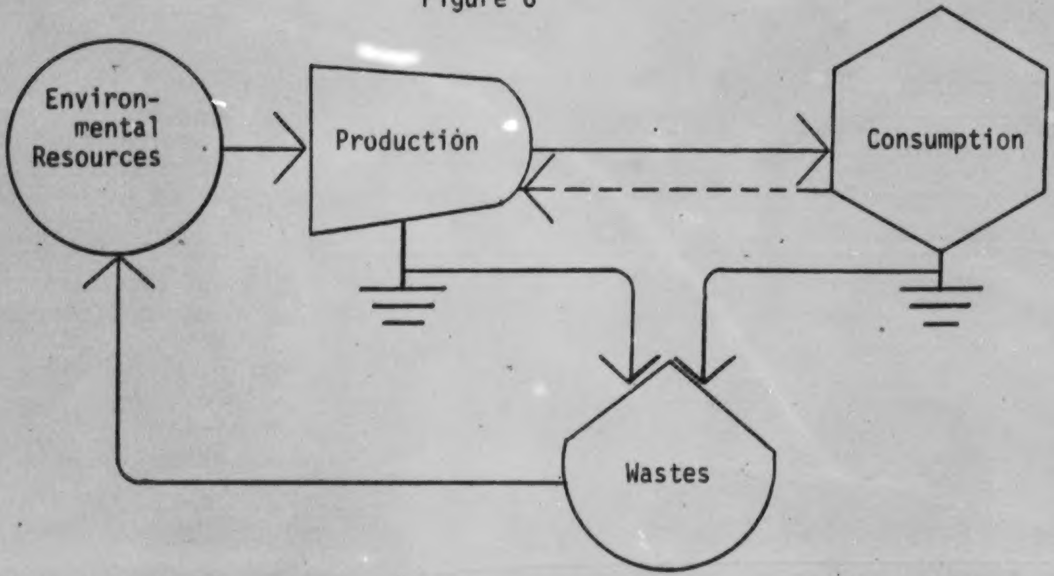
[9] Boulding, Kenneth E. "Economics and Ecology," in Future Environments of North America. Darling and Milton, eds. pp 225-234

[10] Bower, B.T. "Residuals and Environmental Management," Journal of the American Institute of Planners, 1971, Vol. 37(4), p. 219.

(2) Wastes (or residuals) from production and consumption activities is the second major aspect of the pollution problem in environmental management. Production activities generate wastes which are discharged to the environmental resource base and likewise, consumption goods themselves produce or become wastes and are imposed on the common pool of environmental resources. Figure 6 depicts this in graphic form.

Figure 6



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As Bower puts it:

> "All production and consumption activities utilize the assimilative capacity of the land, air, and water environments. While the services rendered by these environments are essential inputs into these activities, traditionally, no prices have been placed on these factor inputs. Hence, far more of them have been used than would be the case if the damage stemming from their use was properly taken into account through pricing."[11]

Extending this point, for the moment, prohibiting the discharge of all wastes into the environment would in effect assign such a high value to pristine environmental quality that the production of goods and services would be impossible since no production process is totally efficient, i.e., all production and consumption produces some wastes.

(3) The Socially Determined aspect of pollution is caused by differences in people's conceptions or images of what constitutes pollution. For example, if one wants absolutely sparkling clear, odorless drinking water and is forced to accept opaque, slightly odiferous drinking water, then the water would be considered polluted. To someone else, without these expectations, the water would not be considered polluted.

In other words, the determination of whether or not a state or undersirable level of pollution exists, is greatly influenced by peoples' desires, attitudes, and values.

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[11] Ibid, p.220

c. Economic Activities and Carrying Capacity

In managing the environment for quality regional growth, questions related to carrying capacity lie at the heart of the problem of finding socially acceptable systems which are also economically viable. These involve decisions related to:

- Acceptable types of products to be produced;
- Pricing policies which take into account waste discharges, physical location and spacing of commercial and industrial activities;
- Desired levels of environmental quality;
- Methods for handling wastes (such as requiring specific levels of "waste treatment" rather than specifying a permitted quantity of discharge or establishing an effluent charge on each unit of residual discharge); and
- Ability of local environment to absorb or assimilate wastes.

In approaching these questions, Bower indicates that "decisions and choices within the environmental sector are linked to decisions and choices in other sectors of the economy. Just as there are limited environmental resources, so there are limited human and capital resources."[12] Carrying capacity as an environmental planning and management tool must explicitly recognize this allocation problem and seek to articulate the multiple tradeoffs among the societal values involved.

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[12] Bower, p.218

Boulding puts these ecologic-economic capacities in perspective with the following comment:

> "Today, ecology rather than economics seems to be taking on the role of the dismal science. All the dismal theorems, however, merely amount to saying that there are limitations . If these limitations are recognized and accepted, and organized action is directed towards them, there is no reason why they should be fatal. If we have, in fact, exceeded the human carrying capacity of the earth (and it is by no means clear that this is so), we will certainly have a rough time getting back to that capacity. There seems to be no inherent reason, however, why, once it has been achieved, a 'spaceship earth' should not be both stable and reasonably agreeable."[13]

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[13] Boulding, Kenneth E. "The Economics of Ecology," Proceedings of the National Conference on Managing the Environment, Office of Research and Development, Washington, D.C.: U.S. Environmental Protection Agency, 1971.

d. Carrying Capacity and the Question of Tradeoffs

The high degree of interrelationship among resources, environmental media (air, water, land), and desired quantity and quality states for humankind's socioeconomic activities underscores the fact that tradeoffs must inevitably be made; among desired production-consumption levels, resource uses, and the desire for a cleaner, healthier and more pleasant environment. From this perspective, carrying capacity becomes a socially determined variable, defined by our understanding of economic, social, and environmental values and their relative contribution to maintaining quality-of-life levels.

A working use of the carrying capacity concept requires that a series of adjustments be made to reconcile the capacity limits related to quality levels in the natural environment with desired levels of consumption of goods and services by society. For example, some of the key issues in examining these tradeoffs in acceptable "carrying capacity" terms are:

- What are the costs and benefits of developing or preserving a resource; of relaxing or enforcing an environmental standard? (For example, reducing air quality standards to allow increased use of coal to combat fuel shortages.)
- What are the ramifications of removing a capacity constraint through new or improved technology, learning, or new resource discovery? (For example, increasing normal crop production ratios through the development of new chemical fertilizers and hybrid plants to help meet world food shortages.)

The tradeoffs and adjustments between our desires and the resource capabilities of our natural environment partly involve technical questions where analytical models can be usefully applied, and partly involve value questions where social and political mechanisms are required.[14] The integration of the two must be accomplished within a carrying capacity-based planning and decision-making process which directs our attention to important issues in manageing urban-regional growth, in handling of wastes and by-products, and in the capability of human and natural environments to support a variety of activities.

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[14] Bishop, et al.,. p. 35.

e. Human System Resources

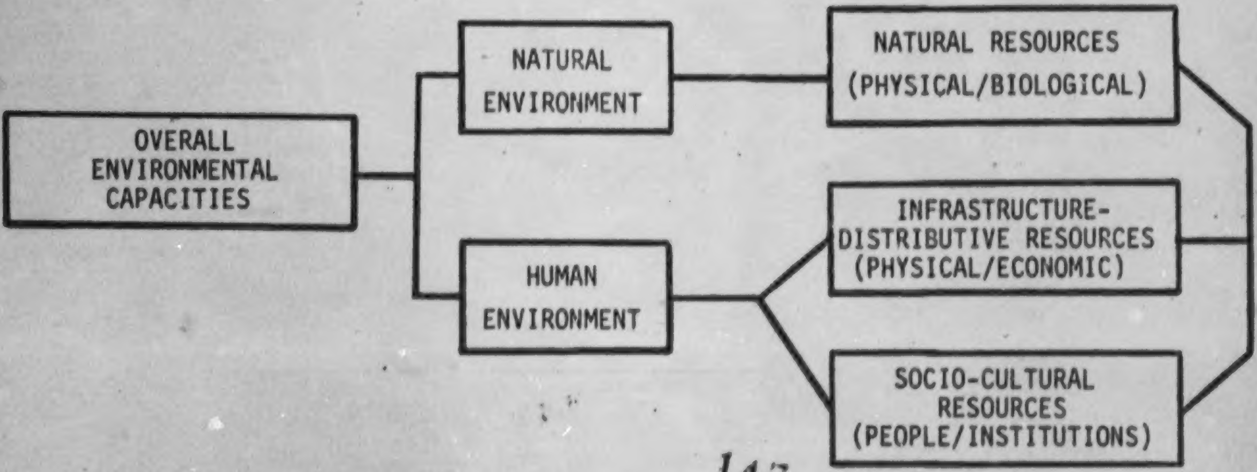
Previously (in Section 4), resources were viewed from the perspective of the natural environment. In urban areas, where much of the living environment is essentially humanbuilt and serves as a means of organizing human activities, it is essential that we broaden our definition of resources to include the human system.

In extending the concept of resources to human systems we must first examine the capability of a region to sustain existing and proposed activities. Consideration must be given to two additional resource systems which define and limit the domains for carrying capacity in a region. These are the:

- Infrastructure and distributive resources of urban areas; and the
- Social-cultural resources of people and institutions.

The realtionship of these resources to the capacities of both natural and human environments is shown in Figure 7.

Figure 7


OVERALL ENVIRONMENTAL CAPACITIES
NATURAL ENVIRONMENT
HUMAN ENVIRONMENT
NATURAL RESOURCES (PHYSICAL/BIOLOGICAL)
INFRASTRUCTURE-DISTRIBUTIVE RESOURCES (PHYSICAL/ECONOMIC)
SOCIO-CULTURAL RESOURCES (PEOPLE/INSTITUTIONS)

(1) Infrastructure-Distributive Resources

The composite of urban activities, both public and private, such as education, health, industry, commerce, recreation, agriculture, and personal services contribute to a set of regional/physical/product/outputs or economic elements which, in turn, contribute to the quality of life. These activities are linked and supported by the infrastructure and resource distribution systems of the region.

The existing regional infrastructure represents the carrying capacity, at least in the short run, of a region's capital stock to provide or distribute needed services, such as transportation, communications, energy, water, and waste disposal.[15] Hence, the rates of flow of these services are limited by the carrying capacity of the urban-regional system and, as such, represent constraints on the rate and quality of regional growth.

(2) Social-Cultural Resources

People and institutions represent the second important resource which operates to govern the human environment. This resource represents the carrying capacity of a region to provide both facilities and services related to education, culture (music, arts, etc.), health, security, recreation, and housing.[16]

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[15] Perloff, p. 11.

[16] Ibid, p. 12.

The institutional and individual values embodied in these resources reflect the present or desired consumption patterns and lifestyles of the residents of a region and are also important determinants of the rate and quality of regional growth. Social scientists have argued that "social and economic development is best measured by observing the latitude and distribution of choices available to a given population."[17] Thus, to pre-specify production capacity limits for the services and facilities of an urban-regional system without consideration of its social-cultural needs and capacities can narrow this range of population choices or possibly expand it for particular segments of the population at the expense of others.[18]

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[17] Bishop, et al., p. 46.

[18] Ibid.

We can now expand upon our previous list of natural system resources (see Section 4) by including the infrastructure and social-cultural resources of the human system. We can, thus, display a more comprehensive resource base for the environment.

ENVIRONMENTAL RESOURCES

Ambient resources	Air, water, open space, quiet and noise zones, sunlight exposure.
Spatial resources	Underground space, available and transitional surface space, airways space.
Ecological resources	Green plants, nongreen plants, animals.
Economic resources	Raw materials (oil, iron, coal, zinc, copper, etc.) for production inputs, capital, labor.
Amenity resources	Seashores, scenic areas, contiguous natural areas (mountains, deserts, lakes), open space.
Infrastructure and distributive resources	Transportation, water and water distribution, wastewater collection, energy (electricity and gas) distribution, communications.
Socio-cultural resources	Educational and cultural facilities, health services, security services (fire, police), recreation services, housing.

Relative to these resource descriptions, the environmental planner and manager must seek to understand such questions as:

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- What are the relevant resource components?
- How do they function?
- How do they interact with and influence other components, or conversely, how are they influenced by other components?
- What factors control levels of environmental quality and how do proposed plans or actions affect those factors?

f. The Question of Ownership

The widespread concept of common property or "free good" resources has little validity (in terms of carrying capacity) for sustaining regional activity and growth. In the evaluation of social accounts, there is now a high cost associated with maintaining the quality of ambient resources--air, water, open space, etc. The industrial firm dumping wastes directly into a stream, airplane flight-paths over residential areas, the individual automobile adding to congestion and air pollution, the building that blocks out the sun are all examples of individual actions contributing to a deterioration in environmental quality for the whole of society. Thus, the levels of activity which should or can be permitted in using common resources is certainly a major issue in the domain of the carrying capacity concept.[19]

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[19] Bishop, et al., p. 47.

ACTIVITIES

FACILITATING NOTES

Do each of these Activities (I - III) as a WHOLE GROUP EXERCISE/ DISCUSSION.

ACTIVITY I

OBJECTIVE: (n) To be familiar with three aspects of pollution which arise from human system conflicts with the natural system.

TO DO: Name three aspects of pollution caused by hunans' economic activities and social values. Think of an environmental problem in which all three are present or exemplified.

OBJECTIVE: (o) To appreciate the importance of considering tradeoffs between our desires for quality of life and the resource capabilities of our natural environment.

TO DO: Using the module text and any previous readings as a resource, identify at least two example environmental problems or issues that require a consideration of tradeoffs between our production, consumption, or quality of life desires and the resource capacity (land, air, water, minerals, etc.) of the natural environment to satisfy these desires without incurring deterioration.

How would you resolve the tradeoff conflicts in your two (or more) examples?

OBJECTIVE: (p) To be familiar with the types of human system resources, their functions, and their interrelationships with natural system resources.

TO DO: On the basis of your present understanding of environmental (human and natural system) resources, fill in the chart which follows with "X"s in the appropriate rows and columns.

After you have filled in the chart as best you can, compare your results with the completed chart for this activity in Appendix C. Discuss and resolve any differences between the two charts.

Hint: *Each of the environmental resources (rows) may be applicable to more than one column within the SYSTEM, RENEWABILITY, or OWNERSHIP sections.*

Chart of Functions and Interrelationships between Environmental Resources

(FILL IN ALL MATCHING OR RELATED ROWS AND COLUMNS WITH "X"s)

	System			Renewability		Ownership			
Class / Resource	Natural	Human		Renewable	Non-Renewable	Private Control	Public Control		
		Infra-structure	Social-cultural				Local	Regional	National
• Ambient									
• Spatial									
• Ecological									
• Economic									
• Amenity									
• Infra-structure-Distributive									
• Social-Cultural									

SECTION 6

RESOURCES

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SECTION 6

LAND USE PLANNING AND MANAGEMENT: CONSIDERATIONS AND STRATEGIES

Upon completing this section you should:

(q) Be familiar with three capacity considerations important for resource management.

(r) Understand the carrying capacity approach to land use planning and some different approaches involved in its application.

(s) Understand some specific mechanisms for exercising land use control.

(t) Understand in detail one method for carrying capacity-based land use planning and decision making.

This section presents some criteria for resource management and a general carrying capacity methodology for land use planning. A major purpose here is to conceptually prepare you for doing a carrying capacity analysis in the Integrative Learning Experience.

"No one should be allowed to own land. Tenure should be a lifetime lease with an option for renewal by one's children. Usage should be conditioned by the requisite that one cares adequately for the land and does not allow it to deteriorate or be destroyed. Destruction of the land for personal financial profit is not ethical behavior and should not be tolerated. The land must be protected for the use and enjoyment of all people.

To the ecologist perhaps the most insane of all meanderings in the business world is that which equates land to paper money and makes the two freely interchangeable. Once sold, the land can be flooded behind a dam, blasted away to open a mine or road, or sent helter-skelter down into streams via erosion. We consider no moral question to be involved in this. The only value judgement for society is made on the other side of the transaction: money received for the land is viewed in a positive light as a stimulus to the local economy."[1]

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[1] Miller, p. 195.

a. Capacity Considerations for Resource Management

From the standpoint of resource impacts, carrying capacity has two aspects important for management purposes:

ENVIRONMENTAL CAPACITIES

- the supportive capacity of the environment to supply resources for certain purposes; and
- the assimilative capacity of the environment to act as a sink for wastes produced from certain activities.

The following provide some simple integrating examples of supportive and assimilative capacities of natural and human systems.[2]

(1)	Natural environment Supportive capacity	Capacity of an aquifer (or other water source) to support water needs of a small community
(2)	Natural environment Assimilative capacity	Capacity of a lake to assimilate municipal/industrial/agricultural wastes
(3)	Human environment Supportive capacity	Capacity of a community tax base to support schools and other public services in a suburban area
(4)	Human environment Assimilative capacity	Capacity of people to assimilate crowding and congestion (and other encroachments) at recreational sites

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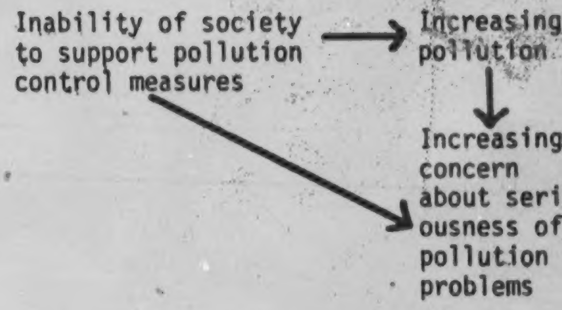
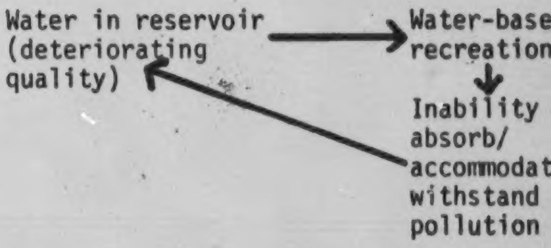
[2] Bishop, et al., pp. 47-8.

(5) Example of interactive effects between supportive and assimilative carrying capacity (human environment)


Inability of society to support pollution control measures
Increasing pollution
Increasing concern about seri ousness of pollution problems

(6) Examples of interactive effect between supportive and assimilative carrying capacity (natural environment)


Water in reservoir (deteriorating quality)
Water-base recreation
Inability absorb/ accommodat withstand pollution

The notion of carrying capacity at the *overall* environmental resource level (natural, infrastructure, and socio-cultural) manages environmental resources via 3 elements. These are:

RESOURCE MANAGEMENT ASPECTS

- Resource capacity
- System constraint capacity
- Social/psychological capacity

(1) Resource Capacity -- emphasizes the biological and resource flow aspects of environmental resources and examines the levels or input rates for an activity (e.g., clear cutting) that can be withstood by the biota (e.g., forest) or the resource flow systems (e.g., rivers) and still return to an unimpaired state

The major question here is: How much resource use (land, air, water, minerals, etc.) can be sustained for an indefinite period of time without altering or degrading the resource?

The underlying management objective, then, is to achieve a maximum sustained yield for a given activity.

Two important factors in analyzing resource capacity are the ability of the resource to produce the kinds of services required, and the ability of the biota or flow system to recover after peak use. For example, the ability of air or water to assimilate certain pollution waste loads over a period of time without permanent deterioration in quality.

(2) System Constraint Capacities -- emphasize the physical limits of resources or of resource processing.

The major questions here are: How much nonrenewable stock (e.g., mineral deposits, fossil fuels, available land) is being developed and used? At what rates can these nonrenewable resources be converted into products and end uses?

An important factor in analyzing system constraints is that the capacity for use of both nonrenewable (e.g., ores, minerals) and renewable resources (e.g., water) may be limited by the capability of the present system to transform and utilize them. For example, a certain forest area might be producing a net annual increase in timber which is greater than can be harvested on a sustained yield basis because it is inaccessible from the current transportation system.

The management objective indicated here is efficiency in resource use and in the operation of resource processing systems.

(3) Social/Psychological Capacity -- emphasizes a wide variety of political/institutional, physical/biological, and social/cultural constraints and examines the overall levels of satisfaction experienced by users or other affected individuals resulting from resource management practices.

The major question here is: "How many people can be handled in an activity at one time before the quality of the experience is lost?"[3] Or to put it more precisely: What are the maximum number of people, vehicles, etc. that can utilize available resources during a specified period of time, for one or several activities, while providing satisfactory experience for the users?

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[3] Bishop, et al., p. 51.

The important management objective here is to maximize the total user satisfaction by allocating resources on the basis of their appropriateness in providing for the desired activities.

An important factor in analyzing social/psychological capacity is that since a particular resource or group of resources may be capable of providing for several different types of activities, some of them will compete for the resources, while others may be compatible. Almost inevitably, this will require a management decision as to which resource use or combination of uses will be pursued. For example, should a particular tract of land be zoned and managed as open space or used for various kinds of residential and commercial development?

b. What is the Carrying Capacity Approach?

The need for planning and control of land use, taking into account the land's capabilities for sustained production and its capacity to support the human demands put on it, should by now be widely recognized (if not practiced) by governments at federal, state, and local levels. It should also be apparent that the process of land use planning needs to be comprehensive, taking into account the multiplicity of interactions between human and natural systems.

The approach to land use planning that is required, therefore, involves more than a simple analysis of the number of people that a given land area or resource base is capable of supporting under specified conditions. Rather, the planning approach involves a carrying capacity analysis examining the interrelated capacities of:

FOCI FOR THE CARRYING CAPACITY APPROACH

(1) environmental resources to support production processes;

(2) production processes to supply essential goods and services, and to provide or maintain acceptable quality-of-life levels;

(3) human system resources to distribute and deliver materials, goods, and services efficiently; and

(4) environmental resources (land, air, water) to assimilate wastes generated from production within acceptable quality levels.

By this definition, the concept of carrying capacity offers a view for conducting human activities by emphasizing that programs and activities must be managed within the capabilities and capacities of the environment to accommodate change and still retain stability and resilience. It also accounts for the net effect of present policies and actions.

A carrying capacity analysis can, thus, provide planners and decision-makers with a useful "tool" for managing and controlling the development and use of land, and with a basis for assessing the environmental implications of various land use proposals, policies, and programs.

c. Applying the Carrying Capacity Approach to Land Use Planning

Based on a comprehensive planning approach to land use management and control, the following is an overview analysis of a carrying capacity approach that can help planners and decision-makers to:

GENERAL CARRYING CAPACITY METHODOLOGY

(1) identify those conditions, events, and decisions (driving forces) -- present and future, local and remote -- that will likely result in significant changes,

(2) inventory existing natural and human resources within a given land area,

(3) estimate how existing resource conditions will be modified by the "driving forces,"

(4) formulate alternative policies and programs for dealing with such change,

(5) estimate the trade-offs involved in these alternatives as a basis for deciding on best courses of action, and

(6) implement the course-of-action decided upon.

(1) Identification of "driving forces"

One of the planners' most important tasks is to identify the conditions, events, and decisions which have or might have an impact on the land area under their scrutiny or jurisdiction. These conditions, events, and decisions, may have already occurred, are occurring now, or are likely to occur in the future. They might occur locally, or elsewhere in the state or nation. Examples of such driving forces are the location of basic and important service industries, federal revenue sharing, the location of interstate highways and other transportation facilities, changes in population and demographic make-ups, policies affecting water and energy supplies, the installation of federal facilities, state and federal supreme court decisions affecting methods of financing public services, etc.

(2) Inventory of existing resources

In order to examine how driving forces might affect changes in an area's natural and human resource base, it is necessary, first, for the planner to inventory existing conditions according to some useful classification scheme, like the one presented in Section 5:

NON-RENEWABLE:
- Special resources
- Amenity resources

RENEWABLE:
- Ambient resources
- Ecological resources
- Infrastructure and distributive resources
- Socio-cultural resources

BOTH NON-RENEWABLE AND RENEWABLE
- Economic resources

A complete inventory would not only assess the quantity of resources available under each one of these categories, but also their quality.

(3) Estimation of possible changes in resources

Using known methodologies and analytic procedures, planners would next estimate and organize the range of possible effects which certain driving forces would have on the resource base of the area as a result of carrying out specified purposes.[4] These can range from such higher order purposes as improving air quality, reducing the unemployment rate, reducing the crime rate, improving quality of life or environmental quality, to more specific purposes such as increasing electric generating capacity, increasing available water supplies, siting and accommodating urban expansion, developing recreation facilities in watershed areas, reducing urban freeway congestion, siting additional wastewater treatment facilities, etc.

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[4] These human-oriented purposes will usually address the four general, highly interactive, areas mentioned previously as: (1) the capacity of the resource base to supply product demands, (2) the capacity of production to supply demands for goods and services, (3) the capacity of delivery systems to distribute materials, goods, and services efficiently and (4) the capacity of the natural environment to assimilate wastes from the production and consumption of these materials, goods, and services.

(4) Formulation of alternatives

Once driving forces have been identified and the range of their impacts on an area's resource base estimated, the planner is faced with the task of formulating alternative ways of accomplishing desired purposes or objectives. Alternatives that would threaten to seriously diminish the carrying capacity of key support systems in either the natural or human communities would, of course, be ruled out of any further consideration at this stage.

(5) Evaluation of tradeoffs

The next step for the planner is that of evaluating viable proposals and competing management alternatives for accommodating the desired purposes or objectives. Since every action alternative involves value tradeoffs, the ultimate merit of a policy or program decision must be judged in terms of its (a) maximizing positive values while minimizing negative ones, and (b) achieving "the good life" or a desired "quality of life" as defined by the members of the community or society.

It is important here that the notion of carrying capacity as a value be reckoned with in the evaluation process.

> "When production demands exceed requisite resource inputs; or the demand for essential goods and services cannot be met by a community's productive capability; or congestion and inefficiency in a community's (delivery) and distributive resources result in frequent and recurring blockages, stops, and delays; or the atmosphere and terrestrial and aquatic environments cannot assimilate wastes and quality levels in these media cannot be maintained at safe and tolerable levels--when carrying capacities such as these are exceeded, society as a whole suffers. Zones of safe carrying capacity are essential to the efficient functioning of a community and to the achievement of personal and social values. In this fundamental way, carrying capacity is an important extrinsic value and one the planner cannot afford to ignore."[5]

(6) Implementation

Once policies and strategies for managing proposed changes have been evaluated and selected, effective means must be found for implementing them within an established and on-going institutional and social setting. The implementation problem can be addressed by focusing on three critical areas in which carrying capacity controls might be exercised: population, economic development, and land use.

CONTROL AREAS

(a) Human population

Human population is considered by many writers as perhaps the most important variable affecting the long-term carrying capacity of land and environmental resources. The basic notion here is that if the population is too high, it unduly stresses the environment and should be decreased; if the population is too low, then population increase can be allowed or stimulated. Of the three factors important for population changes--fertility, mortality, and migration--only the latter effects very rapid changes in the population of an area.[6] For example, it was found that more than 70 percent of the persons entering adulthood during the 1950-1960 decade left some mid-western rural counties; and instances were found where the median age in a county rose by 10 years in just a single decade because of the out-migration of young people.[7]

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[5] Bishop, A.B., et al., p. 141.

With this great potential for population change due to migration, it would appear desirable to devise some means to effect or control rapid population changes in a given area. Unfortunately, although the federal government has in the past been able, through legislation, to effect rapid population increases in certain areas of the country (e.g., homesteading laws in the American West, National Housing Act of 1937 which established the Federal Housing Administration, establishment of an interstate highway system),[8,9] it has maintained a laissez-faire posture in helping to reduce population in overburdened areas (e.g., a California statute prohibiting the transporting of indigent persons into the state during the great depression was struck down by the U.S. Supreme Court.)[10] Nevertheless, public laws, whether federal, state, or local, would appear to offer an effective means of controlling population density in specific areas.

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[6] Alonso, William. "Urban Zero Population Growth," in The No-Growth Society, Olson, M. and Landsberg, H.H. (eds.), New York: W.W. Norton and Co., Inc., 1973, pp. 201-4.

[7] Bishop, et al., p. 142-3

(b) Economic development

Migration also appears to be strongly influence by economic development--in particular, the business cycle where higher migration rates are

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[8] Ibid, p. 144.

[9] The federal government's FHA and interstate highway policies have contributed to the depopulation of major American cities and to the development of urban sprawl by encouraging or allowing people to live great distances from their work.

[10] Ibid, p. 143-4.

seen in areas with greater investment and wealth, with lower immigration in less prosperous areas[11] (e.g., the high influx of southern rural poor into the more affluent northern metropolitan counties between 1945 and 1970; the state of Utah's out-migration in-migration figures from 1960-1970 which were proportional to the respective drop, then rise, in the net per capita income).[12] Thus, economic investment and activity would also appear to be an effective means for controlling both population and urban growth--and, ultimately, the use of environmental resources which this growth entails.

(c) Land use and land use planning

Most of the land in the United States--about two-thirds of it--is privately owned and will probably remain so in the near future.[13] Because of this, government at federal, state, and local levels has at its disposal several means for controlling the use of private land. These are of four types:[14]

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[11] Alonso, p. 202.

[12] Bishop, et al., p. 145.

[13] Clawson, America's Land and Its Uses, p. 10.

[14] Ibid, pp. 10-12.

- Power of eminent domain--where private land needed for public purpose can be taken (e.g., highway rights of way, slum clearance, park additions).

CONTROL MECHANISMS

- Taxation--where real estate or property taxes strongly influence (1) who can and cannot afford land and the structures on it (whether natural or built), and (2) the size and quality of the land and its structures which one can afford.
- Police power--where the most common form is through zoning ordinances which tell landowners what they may not do with their land, and thus by inference tell them what they may do (e.g., zoning may prohibit industrial or commercial activity within a prime residential neighborhood). Other forms of police power are subdivision regulations which establish minimum-size building lots, and building and health codes aimed at protecting people from substandard residential structures.
- Power of the public purse--by far the most important, where both land use and land-owners are materially affected by the way in which governments at all levels, but especially the federal, spend funds for various public purposes. Examples of this type of control or influence are government financed research on land use; government resource-management activities in flood protection, irrigation, etc.; government subsidized highway, airport, railroad construction, and electric power production and transmission; ogvernment financial assistance for forest fire control; and government subsidies to farmers for soil conservation, reduction of crop acreage.

Far greater control over land use, however, can be exerted through careful planning. For example, areas important to aquifer recharge, wildlife preservation, agriculture production, or historical and scenic preservation can be protected from housing and industrial encroachment;

airsheds and watersheds can be protected from industrial pollution; urban structures (utilities, roads, public facilities) can be determined ahead of time to minimize inconvenience to newly developed areas and to lower land acquisition costs; and housing developments can be located ahead of time to enhance compatibility with industrial areas, airports, etc.

Applying the carrying capacity approach as a basis for land use planning, management, and control means: (1) viewing the environment of a given area as a support system for numerous, interdependent and competing activities and systems, and (2) determining the limiting conditions and capabilities of that environment to absorb, withstand, or sustain these activities without declines or unacceptable changes in quality levels.

> "The time has come when we must all develop respect for air, water, land, and living things. We are all dependent on the same life-support system of earth and must protect it if we are to survive."[15]

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[15] Miller, p. 196.

ACTIVITIES

FACILITATING NOTES

1. Activity I should be carried out as a GROUP exercise with individual teachers responsible for:
   - looking up carrying capacity definitions in the specified readings;
   - looking up and characterizing the various carrying capacity steps, control mechanisms, and ecological planning steps specified.
2. Activity II should also be conducted as a GROUP exercise. However, teachers can divide up the responsibility for reading and presenting for analysis the two land use case studies presented in McHarg's Design with Nature, pp. 31-41 and pp. 103-115.

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OBJECTIVES:

(q) To be familiar with three capacity considerations important for resource management.

(r) To understand the carrying capacity approach to land use planning and some different approaches involved in its application.

(s) To understand some specific mechanisms for exercising land use control.

READING: Foin, Jr., Theodore C. Ecological Systems and the Environment, Chapter 8.

TO DO: 1. In a group discussion, review the distinctions between the three aspects of environmental resource management--resource capacity, system constraint capacities, and social/psychological capacity.

Prepare a chart summarizing your conclusions as follows:

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Characteristics / Type of Capacity(ies)	Emphases	Major Questions	Management Objectives
Resource			
System Constraint			
Social/ Psychological			

2. Compare the definition of carrying capacity presented in the module text with at least two other definitions you have run across in your previous readings (e.g., DASMANN, ODUM & ODUM, MILLER, McHARG). Which definition is the most comprehensive, specific, useful?

   Identify the four human-oriented purposes to which carrying capacity analysis and land use planning are ultimately directed.

   Summarize each of the six steps of the carrying capacity approach and give an example of each that is not provided in the text.

3. Compare the land use control mechanisms presented in both the module text and in the reading (FOIN). Synthesize the two into one list.

   Compare the five steps of ecological planning (FOIN) to the six steps of the carrying capacity approach (MODULE TEXT). Synthesize the two sets of steps.

   Describe the major features, steps, advantages or disadvantages of the five land use planning methods described in FOIN, pp. 193-205.

OBJECTIVE: (t) To understand in detail one method for carrying capacity-based land use planning and decision making.

READING: McHarg, Ian. "Ecological Determinism," in Future Environments of North America, Darling & Milton (eds.), 1966, pages 529-533.

McHarg, Ian. Design with Nature. 1971. Pages 31-41 ("A Step Forward"). Pages 103-115 ("Processes as Values").

ADDITIONAL READING:

Caldwell, Lynton K. "The Ecosystem as a Criterion for Public Land Policy," in Man's Natural Environment: A Systems Approach, Russwurm & Sommerville (eds.), 1974, pp. 295-310.

Dasmann, Raymond F. Planet in Peril, 1972, Chapter Five.

TO DO: In a group discussion--

- Compare the six steps described in the "Ecological Determinism" article by McHarg with:

  (1) the six carrying capacity steps described in the section TEXT,

  (2) the five ecological planning steps described in FOIN, and

  (3) the steps actually carried out by McHarg in Design with Nature, pp. 31-41 and 103-115.

  SYNTHESIZE all of these into one set of steps.

- Considering McHarg's overlay analysis-based land use plans (pp. 31-41 and/or 103-115), decide on one or more of the land use CONTROL MECHANISMS (e.g., taxation, zoning, etc.) which you would use to implement any one (or both) of these plans.

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The written text, readings, and activities of this INQUIRY were organized and presented to provide you with a knowledge base for a carrying capacity approach to land use planning and management. It may be useful now to review as a group the objectives stated at the beginning of this section before proceeding to the INTEGRATION.*

As a group, have you covered the material thoroughly enough to understand:

(1) Types and patterns of land use that are prevalent in the United States?

(2) Types and sources of natural resource pollution that exist?

(3) How attitudes and values contribute to resource utilization policies and practices?

(4) Natural systems structure and processes?

(5) How the notion of carrying capacity applies to natural systems and its resources?

(6) How conflicts exist between human demands for resources and natural systems' capacities to satisfy demands?

(7) How the notion of carrying capacity applies to human systems and the desires for quality of life?

(8) Some important aspects of resource management?

(9) A carrying capacity planning methodology?

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*See Objectives (1) through (9) on the Goals and Objectives chart at the beginning of the Inquiry, p. .

The INTEGRATION presents a skills development activity in which the teacher becomes part of an anticipatory planning and decision-making process for determining the optimal, long-term uses of land resources in a specific area.

INTEGRATION

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INTEGRATION

The purpose of this INTEGRATION is to provide you with an opportunity to synthesize and apply the knowledge and understanding you acquired in the INQUIRY to a land use planning and decision-making task. The INTEGRATION requires you to analyze a region's carrying capacity and to develop a plan or set of recommendations for the future development or use of the land consistent with a stewardship worldview and with the land's capacity to sustain and satisfy human demands on its resource base without incurring degradation.

After completing the INTEGRATION you should:

(F) Have developed skills in applying a carrying capacity methodology to land use planning and decision-making.

1. Estimated time to complete the INTEGRATION is 10-12 hours.

2. Keep in mind a general order for proceeding through the INTEGRATION activities:

   - read over the entire section and familiarize yourself with the contents; familiarize yourself with the land use maps (9) and reread the EXPLANATION OF DATA MAPS information;

   - do the MAPPING AND CARRYING CAPACITY ANALYSIS following the instructions on pp.

   - consider the evaluation questions described in the TRI-COUNTY COMMISSION introductory letter (also the Environmental Impact Checklist) in analyzing the physical, social, and aesthetic impact of the mining operation on the Tri-County Region;

   - develop a brief report outlining your land use reccomendations for the Tri-County Region based on your carrying capacity analysis and your answers to the above evaluation questions.

3. Once you and the other teachers have completed the mapping or overlay analysis, it is recommended that you re-read the Commission introductory letter and Environment Impact Checklist to guide you in your utilization of the mapping data. Synthesizing the environmental concerns in these two documents will constitute the basis for your report to the Tri-County Regional Planning Commission.

4. Follow the steps of the MAPPING AND CARRYING CAPACITY ANALYSIS INSTRUCTIONS very carefully as these will tell you (1) how to develop overall synthesis land use maps from the nine separate ones, and (2) when to begin the data analyses and discussions required for developing your report.

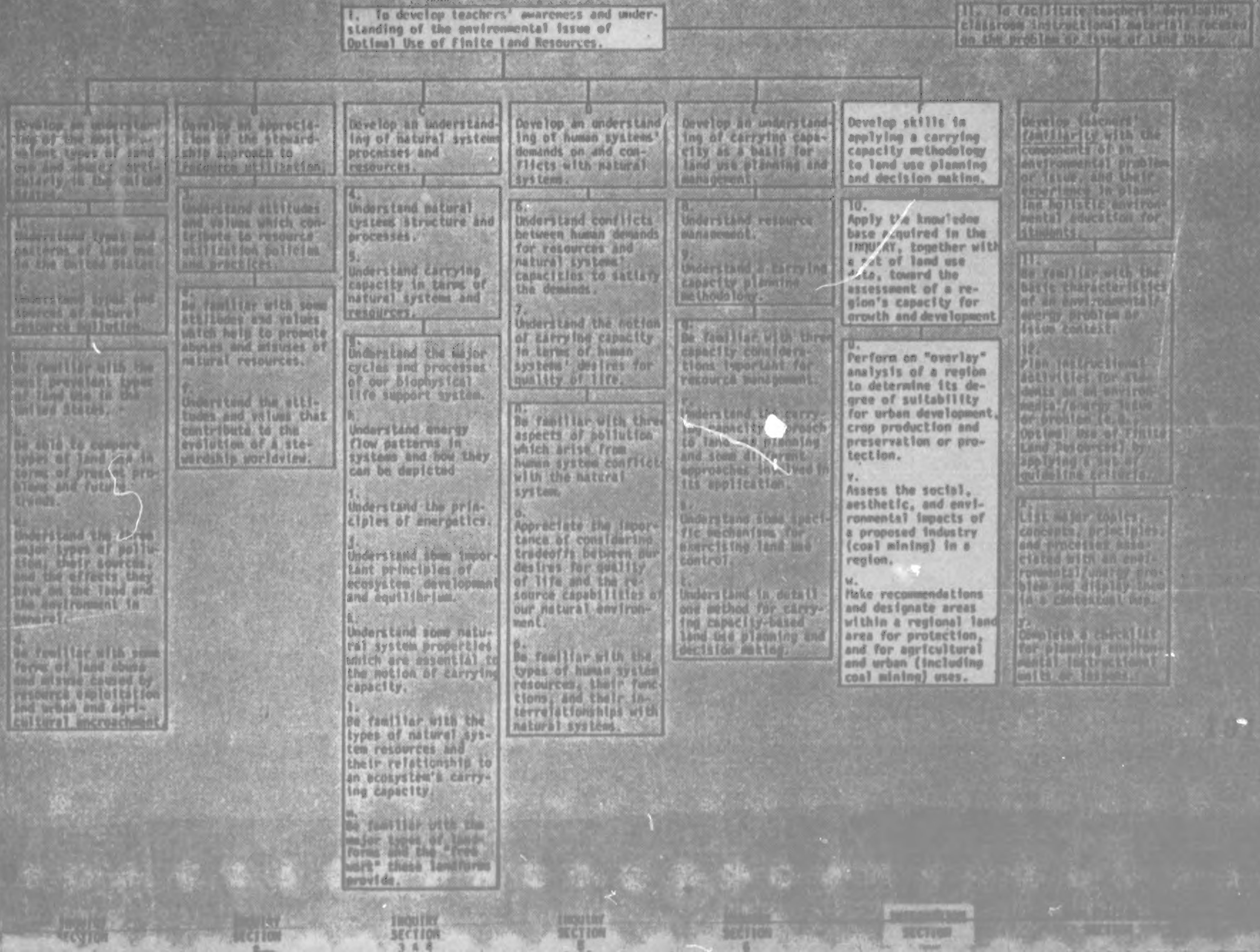
5. Remember that any information you need regarding a particular land use map can be found in the EXPLANATION OF DATA MAPS descriptions, pp.

6. Keep in mind that the MAPPING analysis requires care, is somewhat time consuming, but is lots of fun.

7. A format for doing your land use report is provided on pp. . You are free to change it or use some other format as you see fit.

The Module's Goals and Objectives Chart follows. Only those goals relevant to information presented in the INTEGRATION are highlighted.

MODULE GOALS AND OBJECTIVES



I. To develop teachers' awareness and understanding of the environmental issue of Optimal Use of Finite Land Resources.

II. To facilitate teachers' developing classroom instructional materials focused on the problem or issue of Land Use.

A
Develop an understanding of the most prevalent types of land use and abuse, particularly in the United States.

1. Understand types and patterns of land use in the United States.

2. Understand types and sources of natural resource pollution.

a. Be familiar with the most prevalent types of land use in the United States.

b. Be able to compare types of land use in terms of present problems and future trends.

c. Understand the three major types of pollution, their sources, and the effects they have on the land and the environment in general.

d. Be familiar with some forms of land abuse and misuse caused by resource exploitation and urban and agricultural encroachment.

B
Develop an appreciation of the stewardship approach to resource utilization.

3. Understand attitudes and values which contribute to resource utilization policies and practices.

e. Be familiar with some attitudes and values which help to promote abuses and misuses of natural resources.

f. Understand the attitudes and values that contribute to the evolution of a stewardship worldview.

C
Develop an understanding of natural systems processes and resources.

4. Understand natural systems structure and processes.

5. Understand carrying capacity in terms of natural systems and resources.

g. Understand the major cycles and processes of our biophysical life support system.

h. Understand energy flow patterns in systems and how they can be depicted

i. Understand the principles of energetics.

j. Understand some important principles of ecosystem development and equilibrium.

k. Understand some natural system properties which are essential to the notion of carrying capacity.

l. Be familiar with the types of natural system resources and their relationship to an ecosystem's carrying capacity.

m. Be familiar with the major types of landforms and the "free work" these landforms provide.

D
Develop an understanding of human systems' demands on and conflicts with natural systems.

6. Understand conflicts between human demands for resources and natural systems' capacities to satisfy the demands.

7. Understand the notion of carrying capacity in terms of human systems' desires for quality of life.

n. Be familiar with three aspects of pollution which arise from human system conflicts with the natural system.

o. Appreciate the importance of considering tradeoffs between our desires for quality of life and the resource capabilities of our natural environment.

p. Be familiar with the types of human system resources, their functions, and their interrelationships with natural systems.

E
Develop an understanding of carrying capacity as a basis for land use planning and management.

8. Understand resource management.

9. Understand a carrying capacity planning methodology.

q. Be familiar with three capacity considerations important for resource management.

r. Understand the carrying capacity approach to land use planning and some different approaches involved in its application.

s. Understand some specific mechanisms for exercising land use control.

t. Understand in detail one method for carrying capacity-based land use planning and decision making.

F
Develop skills in applying a carrying capacity methodology to land use planning and decision making.

10. Apply the knowledge base acquired in the INQUIRY, together with a set of land use data, toward the assessment of a region's capacity for growth and development.

u. Perform an "overlay" analysis of a region to determine its degree of suitability for urban development, crop production and preservation or protection.

v. Assess the social, aesthetic, and environmental impacts of a proposed industry (coal mining) in a region.

w. Make recommendations and designate areas within a regional land area for protection, and for agricultural and urban (including coal mining) uses.

G
Develop teachers' familiarity with the components of an environmental problem or issue, and their experience in planning holistic environmental education for students.

11. Be familiar with the basic characteristics of an environmental/energy problem or issue context.

12. Plan instructional activities for students on an environmental/energy issue or problem (e.g., Optimal Use of Finite Land Resources) by applying a set of guideline criteria.

x. List major topics, concepts, principles, and processes associated with an environmental/energy problem and display them in a contextual map.

y. Complete a checklist for planning environmental instructional units or lessons.

After completing INTEGRATION Sections 1 and 2, you should be able to:

(10) Apply the knowledge base acquired in the INQUIRY together with a set of land use data to assess a region's capacity for growth and development.

The INTEGRATION is in two parts: (1) Introductory Materials introduce the scenario and provide data for the Task Force: (2) Carrying Capacity Analysis Materials enable you to do the following:

- Perform an "overlay" analysis of a region to determine its degree of suitability for urban development, crop production, and preservation or protection.
- Assess the social, aesthetic, and environmental impacts of a proposed industry (coal mining) on a region.
- Make recommendations and designate areas within a regional land area for protection, agricultural and urban (including coal mining) uses.

This section presents the following materials for the purpose of orienting you to the scenario:

- Introductory letter from the Tri-County Regional Planning Commission
- Various "Letters of Concern" from individuals and organizations concerned about this land use problem area
- Tri-County Investors Association: "Welcome" letter and regional statistics.

TRI-COUNTY REGIONAL PLANNING COMMISSION

Dear Task Force Member:

The Planning Commission for the Tri-County Region of Pacifica is happy to welcome you to the special Task Force which has been formed to report on the carrying capacity of the three counties in our region: Pacific, Walnut, and Carbon.

Our reason for this is that the Madison Mining Corporation proposes to develop coal mining and coal gasification operations in the region and has presented a rather strong case to the planning Commission to support their proposal--a description of Madison Mining's proposal is attached. Madison Mining has also requested that certain zoning changes be made in the region to accommodate their siting and operations plans.

To complicate this matter, certain groups--notably the Santa Eva Environmentalists (SEE)--have objected on the grounds that this development will cause serious damage to the ecology of the area and will affect not only the land at the mining operation sites, but will have spin-off repercussions affecting the entire Tri-County Region (letters of concern are also attached.) Thus, the Regional Planning Commission has been asked to make a judgment on the desirability of allowing Madison Mining to move in, and the Commission, in turn, has formed the Task Force--of which you are a member--to advise it.

We request, therefore, that the Task Force study the situation, carry out the necessary analyses, and make recommendations, with supporting arguments, on the following questions:

Q1. Can the Tri-County Region accomodate the projected increase in population--resulting directly or indirectly from the mining operation, on a long-term basis?

Q2. What kinds and amounts of energy and other resources are required to support these people and their lifestyles? Does the Tri-County Region have the necessary energy and resources?

- Analyses will require: A determination of whether or not there is a net energy gain from the proposed mining operation. That is, does the total "cost" (energy, goods, services) of accomodating the proposed mining operation, and the subsequent increase in population, exceed the total "benefit" to be gained from the coal? Consider possible sources for acquiring additional energy, water, food, etc. if needed.

Q3. Should the mining company be allowed to begin operations in the region? If so, what sort of requirements or restrictions, if any, should be placed on the mining operations?

- Analyses will require: A determination of what, if any, kinds of restrictions or limitations should be placed on the mining operations in order to ensure a desired level of environmental quality for the region. Consider such things as plant site, pollution and waste controls, types of mining allowed, land reclamation requirements, etc.

Q4. What areas in the region are the most suitable for urban and recreational development to accomodate these people? What areas are least suitable for urban development and should be zoned for agriculture or for production?

- Analyses will require: A determination of locations for accomodating increased populations within the region while maintaining an optimal balance between the denands for both developed and protected land. Consider land required for residential and industrial building, transportation systems, agricultural use, recreation and aesthetic beauty, etc. THIS IS THE ESSENCE OF THE PROBLEM PRESENTED BY THE MINING PROPOSAL. ONCE THE COAL IS EXHAUSTED, THE DEVELOPMENT WILL REMAIN. HOW IT PROCEEDS IN THE NEAR FUTURE WILL CHANGE THE FACE OF THE TRI-COUNTY REGION FOR GENERATIONS TO COME, AND PERHAPS PERMANENTLY.

Q5. What are the implications of accomodating this population growth in terms of maintaining an optimal environment and a desired quality of life?

- Analyses will require: A determination of the long-term social and aesthetic implications of the mining operation and resulting population increase. Consider such things as (1) strip mining devastation, (2) ruined scenic areas, historical sites, etc., (3) energy required to recover or restore scenic or prime agricultural land, (4) effects on remaining populations after the coal runs out, (jobs, goods and services, etc.).

To assist you in your task of answering these important questions, we are enclosing the following:

1. TRI-COUNTY REGIONAL INFORMATION (Courtesy: Tri-County Investors Association)
   - "WELCOME" Letter (description of the Tri-County Region)
   - Vital statistics
2. CARRYING CAPACITY ANALYSIS MATERIALS (Courtesy: NALOD, INC.)
   - Memo from NALOD, Inc., (Introduction to the Carrying Capacity Problem Focus)
   - Environmental Impact Checklist
   - General comments and Instructions Regarding Determination of Intrinsic Land Suitability
   - Data Maps (9) and Explanations of Data Maps
   - Master Matrix of Intrinsic Land Suitability

In presenting your findings and recommendations to the Commission, I would like to request that you prepare a formal report which addresses not only the above set of questions but also the questions in the MEMO and ENVIRONMENTAL IMPACT CHECKLIST, both of which were generated by NALOD, Inc. To expedite the organization of the report, may I suggest that you synthesize all of these questions in devising general headings and sub-headings in which to present your findings, conclusions, and recommendations.

I expect that the regional information and vital statistics provided by the Tri-County Investors Association and the overlay maps provided by NALOD, Inc. will be useful to you as a data base for your report. In making your report, would you also indicate any additional resources or information that proved helpful.

If this office may be of any further assistance to you, please let us know.

Good luck!

Sincerely,

Louis D. Detweiler
Chairperson
Tri-County Regional
Planning Commission

From: The Madison Mining Corporation

To: Tri-County Regional Planning Commission

Gentlemen:

We are seeking your support for a venture which has the potential to bring immense benefits not only to this region, but to the nation as a whole.

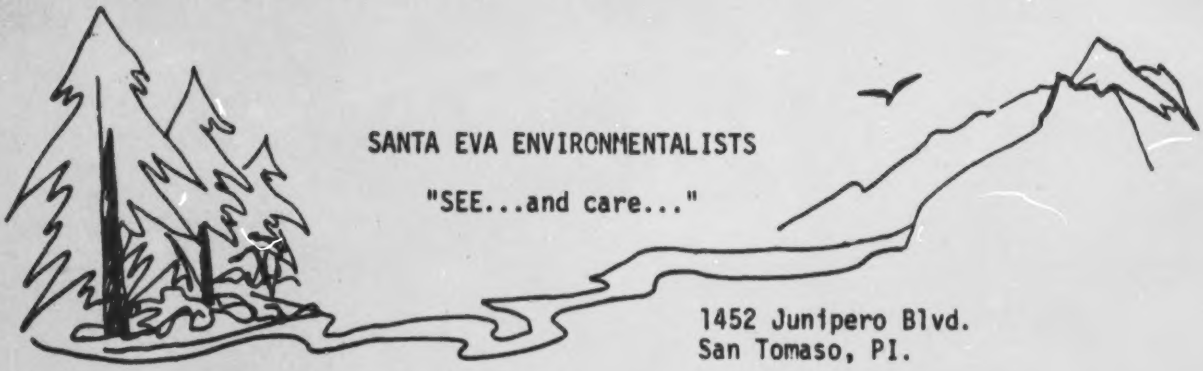
As you know, the current shortage of fossil fuels has made it economically feasible to extract raw materials in areas which would have been prohibitive before. Several such areas--particularly in the Dogen hills--offer fairly large deposits of sub-surface coal.

It is our intention to extract this coal and build a plant for its gasification on an appropriate site. Due to these new mining and processing operations, we project several benefits to your region, including, of course, a substantial increase in tax revenues, a variety of new jobs for approximately 5,000 people, and a significant increase in the amount of new business and retail services which will be attracted to your area in the near future. We estimate that over a 10 year span, our operation should help to attract approximately 85,000 new residents to this region.

Madison Mining has successfully established twenty-seven coal mining operations during the past five years, and has a staff of experienced engineers and other specialists who have been trained to implement such operations with a minimum of disturbance to the surrounding environment.

Since the location of the coal deposits involve several different zoning areas, we request that you consider making the appropriate zoning changes to accommodate our intended plans. Your cooperation in this regard will be greatly appreciated since it will enable us to begin producing the coal which our nation so badly needs.

We eagerly await your decision in this matter which we are certain will greatly benefit the future prosperity of your region and, then, the general welfare of your citizens.



SANTA EVA ENVIRONMENTALISTS

"SEE...and care..."

1452 Junipero Blvd.
San Tomaso, PI.

To: The Members of the Carrying Capacity
Task Force

Ladies and Gentlemen:

We find ourselves at a crucial point in the history of our region. The steady growth of population in the Rio Verde watershed over the past fifty years has gradually diminished the amount of undeveloped land available to maintain the natural systems on which the physical health of the region depend, and the unspoiled beauty which contributes to our psychological health. When population growth occurs in such small and diverse increments it is hard to perceive, to predict, or to control. Today we have been given the opportunity or challenge to make a single decision which will have massive effects not only on our own environment but on that in which our children must live.

In order to assess the impact of the coal industry on this area, it is important to examine some of Madison Mining's statements.

1. Madison says that strip mined land can be not only reclaimed but made more productive.

This is only partly true. If topsoil is carefully saved or is brought in from somewhere else (where?), the potential fertility of the land can be restored. However this greatly increases the cost of producing the coal, a cost which is then passed on to the user. The disruption to the area's ecology cannot be avoided, and even if great care is taken, important parts of the chain such as soil or unique species which live in the area, may be lost.

2. Madison assures us that the Rio Verde has plenty of water to meet its coal mining and processing needs.

It is true that mining and preparing coal requires only 450 gallons of water per ton, of which only 25 are lost. However the movement of sediment and minerals resulting from the disturbance to the land, and the leaching of contaminated materials into the aquifer may have serious effects on all water in the area. A great deal of water is also needed to reclaim the stripped land. In addition, the proposed coal gasification and liquifaction plant will require two to five billion gallons of water a year to maintain a productivity of 250 million cubic feet of gasified coal a day. If, instead, they transport the coal to some other area where water is more plentiful (not in this state), the cost is increased again.

3. Possible effects on air quality should also be considered, as well as the strain additional people and activity will put on the region's ability to supply our present needs.

We urge you to think carefully about all these factors before making your recommendations. Our staff will be happy to talk with you further if you desire.

Sincerely,

Margeret E. Rohan

Margeret E. Rohan
Chairperson

WESTERN WILDFOWL ASSOCIATION
1460 Lakeview Avenue
Peterson, PI.

Carrying Capacity Task Force
c/o Regional Planning Commission
223 Jefferson Street - Suite 106
Santa Eva, PI.

Dear Sirs:

Although our organization may be known to you primarily as an association of sportsmen, we have a long history of conservation activities as well. It is out of this concern that we are writing to you now.

You may not be aware that the marshy areas bordering the lower reaches of the Magella River and San Tomaso Bay, particularly the Mills Marsh and the State Game Lands, provide a refuge for large numbers of migrating and indigenous waterfowl. We have been informed that the operations of a stripmine and processing plant such as have been proposed would not only use immense amounts of water, but would produce an effluent which would pollute the marshes and destroy the waterfowl's habitat.

The accessibility of good hunting has long been a major attraction of the Tri-County Region. The number of birds killed each year by hunters does not threaten their habitat or their species. The Madison Mining operations would, however. We also feel a responsibility to people in the areas where the birds migrate to and from, not to allow destruction of the birds they also depend on.

We hope you will give this problem careful consideration in making your recommendations to the Regional Planning Commission.

Sincerely,

Harry Lebec

Harry Lebec
Chairman

INNER CITY CAUCUS OF SAN TOMASO

1602 - 32nd Street
San Tomaso, PI.

Dear Committee Members:

We have been hearing a lot about how the new mine is going to bring jobs to the people of this town. Well, we think more jobs are a great idea, but we are worried about who the jobs are going to be for.

Big Business has conned the people into voting to start new industries in too many places with high unemployment and then they found out that the jobs were for people from out of town.

So before you let Madison Mining move in, make them sign an agreement to set up a training program for local people (at all jobs levels--not just unskilled labor!).

We want economic justice too!

Yours truly,

Leroy Johnson

Leroy Johnson
Secretary of the Caucus

TRI-COUNTY PROPERTY OWNERS
ASSOCIATION

2400 Oleander Lane
Happy Valley, PI.

Dear Sirs:

We are writing to you out of concern over a threat to our constitutional rights as American citizens.

The issue at hand is greater than a simple decision about whether or not to allow a new industry to move into our region (although such a move will certainly have a beneficial effect on our economy). The procedures by which this decision is reached may have implications which extend far beyond the present case.

Specifically, we understand that a possible result of your deliberations might be a regional development plan which would prescribe in what ways various parts of the Tri-County region may or may not be used. The regional planning authority would have to approve any proposed change in land use, and could effectively block sale of property to individuals or companies who did not meet its requirements. This would represent an extension of government power over the right of individuals to dispose of their own property.

It is hard to imagine what threat Madison Mining could pose which could be greater than this attack on property rights, which strikes at our entire system of civil liberties. Our organization represents a significant portion of the responsible taxpayers of this region, and is determined to see that such an infringement of our rights does not occur.

We trust that you will consider these facts in making your recommendations to the Regional Planning Commission.

Sincerely yours,

WTGerhard

William T. Gerhard
President

Rio Verde Valley Farmers' Co-op
1500 Main Street
Walnut Acres, PI.

Task Force
c/o Regional Planning Commission
223 Jefferson Street - Suite 106
San Tomaso, PI.

Dear Sirs:

Although we have felt in the past that the ecology movement people sometimes go too far in trying to keep land wild that could be used productively, right now we want to add our support to their arguments against the Madison coal mining operation.

The Rio Verde valley is one of the most productive agricultural areas in the state. It supplies fruit and vegetables not only to the surrounding communities, but exports to the rest of the country as well. It has taken millions of years for the river to lay down the soil that makes this possible. Good soil is a natural resource too, as valuable as coal, as anyone who has ever tried to farm poor soil knows. No matter what the company says, we find it hard to believe that what took God millions of years to do they will be able to replace in ten or so years.

Meanwhile, what is supposed to happen to the farmers? This land is mainly owned by families, not large corporations that can afford to wait around until the miners are done with it. We won't be able to come back and pick up where we left off. But if the zoning is changed, property taxes on land which is suddenly more valuable will force most of us to sell.

So for the sake of the soil and for the people whose livelihood is in the land, please don't let Madison Mining buy it up!

Sincerely,

Joe Miller

Joseph E. Miller
President

energy...
for your future

RIO VERDE GAS & ELECTRIC CO.
3032 Pacifica Avenue
San Tomaso, PI.

The Carrying Capacity Task Force
c/o Regional Planning Commission
223 Jefferson Street - Suite 106
San Tomaso, PI.

Dear Ladies and Gentlemen:

In the past decade the growing population of the United States in general and the Tri-County region in particular have placed a steadily increasing demand on our capability to supply electric power. The hydroelectric power plants which have served us in the past are being pushed towards their limits, but use of oil powered plants to produce electric power will force the United States to place unwise reliance on other countries.

The best solution proposed so far is to make use of our nation's deposits of coal. We are fortunate in the Tri-County Region to have a local source which if properly exploited will enable our region to supply the energy needs of its growing population for many years. The savings in transportation costs will be passed on to the customer.

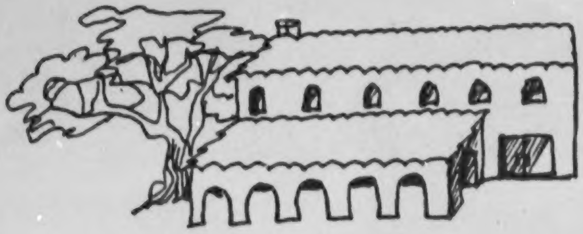
We therefore respectfully suggest that you include in your recommendations to the Regional Planning Commission a provision that all fuel produced within the Tri-County region shall be reserved for use in this area.

Thank you.

Sincerely,

WB Harriman

Wallace B. Harriman
Public Services



Rio Verde Historical Society
360 Pacifica Blvd.
Two Creeks, PI.

Dear Ladies and Gentlemen:

We are writing to you in the name of the cultural heritage of our region.

In these days when things change so rapidly, it grows ever more crucial to preserve what remains of the past since an awareness and understanding of our forefathers' deeds and ways gives us a sense of continuity and stability.

One of the most important historical sites in the Tri-County region is the Odum Ranch hacienda a few miles northeast of Port O'Connell. The building, which was constructed in 1787, was the home of a notable Spanish family whose Rancho Las Pulgas was renowned up and down the coast. In 1851 a sailor named Jeremiah Odum left his ship in San Tomaso Bay, and taking refuge at the rancho, eventually married the oldest daughter of the family who inherited the rancho. Their descendents owned the land until shortly after World War II.

Today it is a favorite tourist attraction, and is visited by several thousand school children each year. It is situated in an area of gently rolling hills which, we understand, cover the coal which Madison Mining has proposed to remove. Its present use as ranch land preserves the character of the original setting. Stripping the land to obtain coal will not only destroy the rancho, but will alter the character of the surrounding land forever.

How can a price be set on our history? The coal that is mined will soon be gone, but with proper maintenance, this testimony to our past can endure to inspire future generations.

We beg you to consider the need to preserve the Odum Ranch hacienda in your deliberations and in your recommendations to the Regional Planning Commission.

Sincerely yours,

Florence C. Wright

Florence C. Wright
Chairperson

Sunshine, Incorporated
Community Developers
22 Rivera Street
Peterson, PI.

Carrying Capacity Task Force
c/o Regional Planning Commission
223 Jefferson Street - Suite 106
San Tomaso, PI.

Dear People:

The Rio Verde region is currently being faced with a great challenge in developing its coal resources. Some groups feel that a new coal industry would prove to be a detriment to our community due to a concomitant growth in population. Which of these points of view turns out to be correct will depend on the decisions which you, and all of us, make in the next few months.

Even without the new coal industry, population growth in this area is bound to occur. There is really no question as to whether to allow it or not. The only thing that can be decided is how it will happen. Surely the axiom of "the greatest good for the greatest number" should be our guiding principle in this matter.

Given this principle, the incursion of the Madison Mining operations can be seen as a blessing, not a curse. Properly handled, the mining operation cannot only help us solve our unemployment problem, but provide cheaper power which will make life easier for everyone. In addition, if the tax revenues produced by the mine are wisely used, the entire region will benefit.

One possible way of reacting to the situation would be to develop a new model community to serve the workers at the mine and processing plant. This would not only place no strain on existing communities, but could serve as an example of enlightened community planning.

We will be happy to talk further about these ideas at any time.

Yours truly,

SARAH LELAND

Sarah Leland
Coordinator

TRI-COUNTY INVESTORS ASSOCIATION

WELCOME!

The three counties of the Tri-County Region include some of the most interesting, prosperous, and beautiful country in the state of Pacifica. Although the state capital, El Dorado, and the state's more heavily populated areas, are only a day's drive to the north, much of the area drained by the Rio Verde and its tributaries is still relatively unspoiled. The region, which consists of Pacific, Walnut, and Carbon counties, covers approximately 1000 square miles, and has a population of 200,000.

The major city of Pacific County (and the unofficial regional capital) is Tomaso, located on the beautiful bay of that name. This city, which dominates the area's industrial and business activity, is home to such nationally known companies as Steinmetz Shoes, Frazetta's Fisheries and Canning Plant, and the Greenriver Meat Packing Co.

Doeland, across the bay, is an early shipping port, now bustling with activity. It contains a major plant for King Kola, is the site for the regional office of the Bank of Pacifica, as well as numerous other state and national organizations. It boasts an international airport which serves the entire region, and is a major terminal of the Great Western Railroad. The harbor receives shipping from many lands as well as providing a base for the flourishing fishing industry.

Mussel bay, the region's harbor, is protected by the sand spit of Lido Beach, a residential/resort community. Scenic hills flank the entrance to San Tomaso Bay. They are part of the Seagate National Recreation Area, a park which provides a recreational escape for city-dwellers and suburbanites alike. Seagate extends north and south, encompassing almost the entire coast of Pacific County. Within it are several lovely seaside communities within easy driving distance of the city, miles of beaches interspersed with scenic rock coast, and several stands of coast redwood, including the famous John Muir Grove.

Walnut County encompasses most of the Rio Verde Valley, and is the heart of the region's fruit and nut-growing industry. Pears, apples, almonds, and, of course, walnuts are the main crops. Rio Verde has grown from a small mill town to a city of 20,000.

In addition to serving the mercantile needs of this thriving agricultural area, it is the site of Greenriver Tool and Die Mfg., Delta Electronics, the nationally known Andersen's Scandinavian Furniture Company, and the El Perfecto Pear Canning Company. In fact the Rio Verde pear festival, held every August, is one of the area's major events of the year.

The farming communities of Oat, Two Creeks, Happy Valley, and Walnut Acres have experienced rapid growth in the past twenty years, and Levitt Valley, a new community, provides a quality suburban environment. Strip City is a largely commercial district serving the needs of the north-south freeway as it enters the region from the north.

Along the Magella River are several cities which date back to the earliest settlement of the region--Peterson and Murphy's Landing--the former being the secondary port of San Tomaso Bay, and the latter being an industrial center. Anyone who has visited Peterson is familiar with the billboard: "Peterson makes, the world takes." Murphy's Landing is the site of the region's major power plant, a coal-fired electrical generating plant, and of a large lumber mill owned by Pacific Timber.

Moving further upstream to Port O'Connell in Carbon County is more riverfront activity at the Magella shipyard, a large concern devoted to building barges, and the mill of Logan's Lumber Company, a locally-based concern. Port O'Connell is also a port devoted to shipping agricultural products (rice and other grains) from the broad interior valley to destinations all over the world.

The southeast corner of Carbon county lies at the edge of a vast agricultural region--"the breadbasket of Pacifica." Its crops include rice, grains, and a fast-growing number of acres devoted to vineyards. Many of the more hilly areas of the region are devoted to pasture for grazing cattle and horses.

The great massif of Mount Angel dominates the central portion of the region, and the ridges that radiate out around it are largely devoted to timber production and recreation. Carbon County is richly endowed with recreational opportunities. Dominy reservoir is a multiple purpose impoundment, serving water supply needs of the county, generating hydroelectric power, and providing high quality water-recreation to the region's citizens. The Bureau of Land Management's quarter million acres within the county are managed under "multiple use--sustained yield" principles--with its strong policy toward present and future timber production.

The Tri-County Region was first settled by the Spanish, who established one of the northernmost missions, San Tomaso, near the harbor in 1782. The ruins of the old mission may still be seen in a park in the present city. During the 19th century, a refitting and refueling station for whalers was established in the harbor and, from time to time, sailors would jump ship and marry into some of the great California ranching families in the area. One of these, Jerimiah Odum, was the owner of the Odum Ranch, now preserved in its natural state as an ecological preserve. His hacienda is the second oldest building remaining in the region.

Peterson was first settled as a trading post for dealing with the Santa Eva Indians. After the Indians settled on the Round Valley Rancheria to the northeast in 1897, the area began to fill up quickly. Round Valley Regional Wilderness is dedicated to the memory of the now extinct tribe. This process was encouraged by the "Little Gold Rush" which took place along the upper tributaries of Flapjack Creek and the Rio Verde from 1900 through 1910. Coal was discovered in the Dogen Hills in the twenties. However, interest in coal has only recently reached significant levels due to the low cost of competing energy sources.

Until the Second World War the area continued to grow slowly. Then the harbor became the site of a massive shipbuilding industry. This growth diminished after the war, but the population which had been attracted to the wartime industry quickly spread into the outlying areas.

Today, the Tri-County Region, well-populated and economically well-balanced, is a haven for the tourist or an opportunity for the investor. We are happy to welcome you to our region. Further information on any aspect of the region's prospects or resources may be obtained from the:

Tri-County Investors Association
1456 Viridian Avenue
San Tomaso, PI. 99702

TRI-COUNTY REGION VITAL STATISTICS

Courtesy: Tri-County Investors Association

STATISTICS FOR TRI-COUNTY REGION:

POPULATION

CARBON County:	50,000 (location of coal mining sites)
WALNUT County:	70,000
PACIFIC County:	80,000
Total:	200,000

Projected population in 15 years at present rate of growth

Without mining industry:	With mining industry:
260,000	360,000

WATER

Present rate of consumption

CARBON County:	7.1 billion gallons/year
WALNUT County:	5.8 billion gallons/year
PACIFIC County:	5.3 billion gallons/year
Total:	18.2 billion gallons/year

Projected rate of consumption in 15 years (assuming present per capita consumption rates)

• without mining industry:	26.0 billion gallons/year
• with mining industry:	31.3 billion gallons/year

Present storage

Dominy Reservoir	19.8 billion gallons/year
Well production	3.5 billion gallons/year
Total:	23.3 billion gallons/year

FOOD

Land area for Tri-County Region:	1,500 sq. mi. (1 sq. mi.=640 acres)

Present rate of consumption

CARBON County:	102,250
WALNUT County:	146,500
PACIFIC County:	164,250
	412,000 tons/year (with 600 sq. mi. or 384,000 acres under agricultural use.)

Projected rate of consumption in 15 years

- Without mining industry: 520,450 tons/year
- With mining industry: 720,050 tons/year

Present rate of yield for 3 counties: 927,089 tons/year

ENERGY

Present rate of consumption for 3 counties

Electricity:	10.49 trillion B.T.U./year*
Gas (natural):	12.00 trillion B.T.U./year
Total:	22.49 trillion B.T.U./year

Projected rate of consumption in 15 years

	Without mining industry	With mining industry
Electricity:	12.86 tril. BTU/yr.	14.99 tril. BTU/yr.
Gas (natural):	14.09 tril. BTU/yr.	18.10 tril. BTU/yr.
Total:	26.95 tril. BTU/yr.	32.09 tril. BTU/yr.

Present rate of production

	Produced in region	Imported to region
Electricity	4.30 tril. BTU/yr.	7.28 tril. BTU/yr.
Natural Gas:	8.26 tril. BTU/yr.	2.75 tril. BTU/yr.
Total:	12.46 tril. BTU/yr.	10.03 tril. BTU/yr.

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*Energy measure of electricity converted from kilowatt hours (KWH) to British Thermal Units (B.T.U.) equivalents for comparative purposes (1 KWH = 3414.43 B.T.U.).

Projected increased rate of production required

Electricity:	5.95 trillion B.T.U./year (upgrading of present plant)
Natural Gas:	12.45 trillion B.T.U./year
Total:	18.40 trillion B.T.U./year**

**Coal produced from the mining operation would create an additional 4.20 trillion B.T.U./year of energy.

SEWAGE (liquid waste)

	Present rate of production	Projected rate of production in 15 years (without mining industry)
CARBON County:	8,812,500 tons/yr.	11,660,156 tons/yr.
WALNUT County:	13,625,000 tons/yr.	15,320,312 tons/yr.
PACIFIC County:	15,562,500 tons/yr.	17,532,032 tons/yr.
Total:	38,000,000 tons/yr.	45,512,500 tons/yr.

REFUSE (solid waste)

CARBON County:	39,250 tons/yr.	48,641 tons/yr.
WALNUT County:	50,500 tons/yr.	52,281 tons/yr.
PACIFIC County:	60,250 tons/yr.	74,128 tons/yr.
Total:	150,000 tons/yr.	175,050 tons/yr.

AIR POLLUTANTS

CARBON County:	26,800 tons/yr.	30,108 tons/yr.
WALNUT County:	23,600 tons/yr.	28,215 tons/yr.
PACIFIC County:	15,300 tons/yr.	25,851 tons/yr.
Total:	67,700 tons/yr.	84,174 tons/yr.

OBJECTIVES:

(u) Perform an "overlay" analysis of a region to determine its degree of suitability for urban development, crop production and preservation or protection.

(v) Assess the social, aesthetic, and environmental impacts of a proposed industry (coal mining) in a region.

(w) Make recommendations and designate areas within a regional land area for protection, and for agricultural and urban (including coal mining) uses.

In order to assist you in accomplishing the objectives listed above, this section will provide you with the following:

- Memo from NALOD, Inc. introducing the carrying capacity problem focus
- Environmental Impact Checklist
- General Comments and Instructions For Determination of Intrinsic Land Suitability
- Data Maps (9) and Explanations of Data Maps
- Master Matrix of Intrinsic Land Suitability
- Mapping and Carrying Capacity Analysis Instructions

NALOD, INCORPORATED
- ENGINEERING - SURVEYING - CARTOGRAPHY - ENVIRONMENTAL IMPACT ANALYSIS -
- GEOLOGICAL SURVEYING -

TO: TASK FORCE MEMBERS

TOPIC: Introduction to the Carrying Capacity Problem Focus

An integral part of your carrying capacity analysis includes a determination of intrinsic suitability for different land uses in the region. This will help you to apply your own judgment on the advisability of the proposed mining operations, and where best to locate the extensive development that would accompany the mining (should you approve it). We recommend that if, in fact, you do allow the mining operations to begin that they proceed with the provision that an ecological regional plan is enacted into law and that it is strictly enforced. Only through this measure will you be able to maintain the region's environmental quality while accomodating the demand for energy and pressures for development.

We are providing you with the nine data maps of the region accompanied by explanatory texts for each one, plus instructions on how to use them. The method explained in the instructions will enable you to move closer to an assessment of the region's carrying capacity. Once you have understood the land's natural processes, and have applied specific criteria to assess the value of these processes, you will have a good idea of which areas are suitable for development and which should be stringently protected.

We have seen Mr. Detweiler's letter to the Task Force outlining the major question and analysis areas he wanted you to address in your report to the Planning Commission (pp.   ). We feel that you should respond to these question and analysis areas quite specifically in the findings and recommendations of your report.

Please do not hesitate to call on us if we can be of further help.

Sincerely,

James C. Nalod

James C. Nalod
NALOD, Inc.

ENVIRONMENTAL IMPACT CHECKLIST

For your report to the Tri-County Regional Planning Commission to be sufficiently comprehensive, you, the task force members, should consider (in addition to the major questions posed in the Regional Planning Commission Memo and the NALOD, Inc. MEMO) the following checklist items. These will help determine the specific content (areas, topics) to be covered, or serve, perhaps, as a guide to possible topic headings or sub-headings. Coverage of most or all of these areas in your report will ensure its usefulness to the Planning Commission.

		YES	NO
I.	Characteristics of the natural environment		
	Does the project site involve a unique landform or biological area, such as beaches, sand dunes, marshes, tidelands or bays?	___	___
A.	Land (topography, soils, geology)		
	Will the project involve construction on slopes of twenty-five percent or greater?	___	___
	Is the project to be located in an area of soil instability (subsidence, land-slide, or severe erosion)?	___	___
	Is the project site located on or adjacent to a known earthquake fault?	___	___
B.	Water		
	Is the proposed project located within a floodplain?	___	___
	Does the proposed project involve a natural drainage channel, stream-bed, aquifer, or aquifer recharge area?	___	___
C.	Biota		
	Are there any rare or endangered species of plant life in the project area?	___	___
	Will any mature trees be removed or relocated?	___	___
	Is the project site adjacent to, or does it include, a habitat, food source, water source, nesting place, or breeding place for a rare or endangered wildlife species?	___	___
	Could the project significantly affect fish, wildlife, reptiles, or plant life?	___	___
	Is the project located inside or within 200 feet of a fish or wildlife refuge or reserve?	___	___
D.	Potential alteration of natural features		
	Will the proposed project result in the removal of a natural resource for commercial purposes (including rock, sand, gravel, oil, trees, or minerals)?	___	___
	Will the project involve grading in excess of 300 cubic yards?	___	___

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[1] Adapted from: Dickert, Thomas G., with Domeny, Katherine R. (eds.) Environmental Impact Assessment: Guidelines and Commentary, University Extension, University of California, Berkeley, 1974.

II. Pollution (air, water, noise, land)	YES	NO
Will the project create dust, fumes, smoke, or odors?	___	___
Will the project involve the burning of any material, including brush, trees, and construction materials?	___	___
Is the project expected to result in the generation of noise levels in excess of that currently existing in the area?	___	___
Will the project involve the application, use, or disposal of potentially hazardous materials, including pesticides, herbicides, other toxic substances, or radioactive material?	___	___

III. Applicable pollution controls and standards		
Will the proposed project require a permit or other approval from any of the following agencies?	___	___
Tri-County Water Resources and Water Quality Control Board	___	___
Tri-County Department of Public Health	___	___
Tri-County Air Pollution Control District	___	___
Tri-County Environmental Resource Conservation and Development Commission	___	___
Tri-County Metropolitan Transportation Commission	___	___
U. S. Environmental Protection Agency	___	___
Does the project require variance from established environmental standards (e.g., air quality, noise, water quality)?	___	___

IV. Impact on infrastructure

A. Circulation		
Is the project expected to cause noticeable increase in pedestrian traffic or a change in pedestrian patterns?	___	___
Will the project result in noticeable changes in vehicular traffic patterns or volumes (including bicycles)?	___	___

B. Water supply and sewage disposal		
Will the project entail the acquisition of water from wells or surface sources for commerical and/or nondomestic use?	___	___
Will septic tanks be utilized for sewage disposal?	___	___

C. Demand for service from special districts and/or municipalities or county		
Will the project require the extension of existing public utility lines?	___	___
Will the proposed project require public services from an agency, district, or public utility that is currently operating at or near capacity?	___	___

		YES	NO
V.	**Social effect**		
	Is the project apt to result in the congregating of more than 50 people on a regular basis?		
	Will the project result in the introduction of activities not currently found within the community?		
VI.	**Miscellaneous**		
	Will the project employ equipment that could interfere with existing communication and/or defense systems?		
VII.	**Land use**		
	Is the proposed project expected to result in other changes in land use, either on or off the project site?		
	Could the project serve to encourage development of presently undeveloped areas, or increases in development intensity of already developed areas (examples include the introduction of new or expanded public utilities, new industry, commercial facilities, or recreation activities)?		
	Does the project involve the construction of more than twenty dwelling units?		
	Is the project adjacent to or within 500 feet of an existing public facility or site for same?		
	Does the project require variance from adopted community plans, policies, or goals?		
	Does the project involve lands currently protected under the Fatherwill Act or an open space easement (which limits kind of use for privately owned land)?		
VIII.	**Visual impact**		
	Is the site for the proposed project adjacent to a designated scenic highway or within a scenic corridor?		
	Will the project obstruct scenic views from existing residential areas, public lands, or public roads?		
	Does the project involve the construction of buildings or structures in excess of 3 stories or thirty-six feet in height?		
IX.	**Sociocultural impact**		
	Will the project require the relocation of people or business in order to clear the construction site?		
	Does the project site involve a known historical or archeological site?		

GENERAL COMMENTS AND INSTRUCTIONS REGARDING DETERMINATION OF INTRINSIC LAND SUITABILITY

The purpose of the Citizen's Carrying Capacity Task Force is to identify the Tri-county region's intrinsic suitability for three prospective land uses: urban, agriculture, and protection.

In this exercise you will use data maps to (1) understand the various natural systems of the region, and (2) determine which land areas are most suitable for protection and for agricultural and urban land use. Up to this point, the method is rational and explicit, using evidence "derived, in the main, from exact sciences."[1] Reconciling the inevitable conflict between areas found suitable for more than one use requires application of one's value system, and is subject to social/economic pressures, not the least of which are "the entire question of demand and the resolution of demand relative to supply."[2] You will decide, therefore, in cases of areas suitable for more than one use, whether multiple co-existing uses can exist there or whether a single use should predominate.

This is the essence of ecological regional planning: (1) look at the land, (2) ask it what it wants to have done to it, (3) analyze the nature of the demand for its use, and (4) provide for the demand in an environmentally compatible manner, enhancing the health of the ecosystem wherever possible. A method which applies directly to use of the data maps accompanies this report. (This method was developed by Ian McHarg and we quote freely from Design with Nature, pp. 103-113, in these instructions).

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[1] McHarg, Design with Nature, p. 105.

[2] Ibid.

We begin our land suitability discussion with the observation that nature is process and value, exhibiting both opportunities and limitations to human use.

> The basic proposition employed is that any place is the sum of historical, physical and biological processes, that these are dynamic, that they constitute social values, that each area has an intrinsic suitability for certain land uses and finally, that certain areas lend themselves to multiple coexisting land uses.[3]

We know the major physical and biological processes that created the Tri-County region and that operate there now. All basic data relevant to these processes has already been compiled and mapped--relief, slope, geology, soils, hydrology, vegetation, land use, and historic, scenic, and environmentally sensitive areas. To make these data useful, they must be synthesized into intrinsic suitability maps and interpreted within a value system.

For each of the basic data maps, a number of factors were selected and evaluated. For example, from the soils map we identify features such as: value for fertility, depth of bedrock, depth to water-table, erosion potential, and bearing capacity (see Master Matrix of Intrinsic Land Suitability). We identify the factors of importance in determining suitability for each prospective land use. Criteria for each of these prospective land uses can be formulated and applied to the mapped factors. This involves actual plotting of data and synthesizing it with data from other maps (see Mapping Instructions).

The Master Matrix of Intrinsic Land Suitability presents criteria for prime agriculture, prime urban, and protection/open space suitability. Since the agriculture suitability map is already completed (see data map #7), you need only prepare synthesized maps for urban use and protection (see Notes on the Master Matrix and Mapping Instructions).

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[3] Ibid, p. 104.

The Soils: Suitability for Agriculture (map #7) is a completed synthesized map example. The text accompanying this map explains in detail the specific method by which several factors--weighted according to specific criteria--were combined to make this map. The Master Matrix shows the factors used in preparation of this map.

The matrix columns entitled "Protection" and "Urban" outline suggestions for the preparation of a map of "Intrinsic Suitability" for each of these land use types. Both types represent important considerations in determining the development site for the proposed mining operations (if the mining proposal is approved). Once you, the members of the Carrying Capacity Task Force, develop and map the factor criteria onto maps depicting the most suitable areas for urban, protection, and agricultural land use, it will be necessary for you to apply your own values in reconciling the inevitable conflicts which arise when the same area proves suitable for two or more uses. For example, prime agricultural land is often eminently suitable for building construction. Therefore, you must decide on the relative merits of using land for food production for future generations versus using it for present-day urban development and the short-term employment afforded by its construction. Certainly the multiple use of some land areas may be permitted if it is assured that intrinsic uses are not compromised.[4] The recognition that certain areas are intrinsically suitable for several land uses can be seen either as a conflict or as the opportunity to combine uses in a way that is socially desirable.[5]

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[4] Ibid.

[5] Ibid.

EXPLANATIONS OF DATA MAPS

MAP	DATA SOURCE
1	RELIEF
2	GEOLOGY
3	SLOPE
4	SOILS
5	HYDROLOGY
6	VEGETATION
7	SOILS: AGRICULTURAL (suitability for crop production)
8	LAND USE
9	HISTORIC, SCENIC, AND ENVIRONMENTALLY SENSITIVE AREAS

DATA MAP 1. RELIEF

The Tri-County Region is blessed with great topographic relief and variety. The Magella River flows through it from the expansive agricultural interior valley through San Tomaso Bay and out to the ocean. The Rio Verde flows through a broad, gently sloping valley surrounded by coastal hills to the West, McHarg Ridge to the Southwest, and the great massif of Mount Angel to the East. Further east, the Dogen Hills are dissected by many small stream valleys, and in the Odum Ranch area, parallel ridges alternate with rich agricultural bottom land. The region's coast is rugged and scenic, with several fine beaches and small erosional-remnant islands slightly offshore.

DATA MAP 2. GEOLOGY

Geology is the prime determinant of the natural systems it supports, i.e., soils, vegetation, landform as climatic moderator, etc.

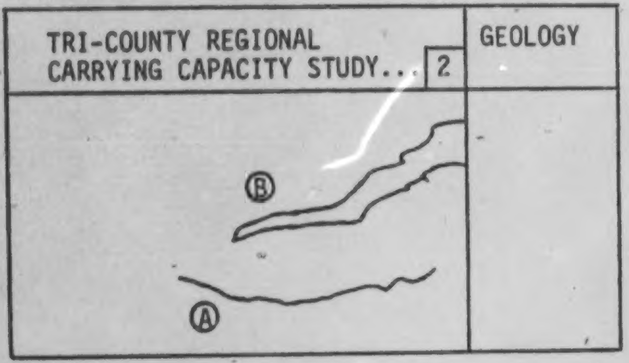
Therefore, the geologic base map is a useful tool for determining the distribution and stability of land forms and slopes, and the location of aquifers--water-bearing rock strata. Bedrock geology interacting with the prevailing climatic regime leads to the creation of soils through a process known as weathering and, in combination with transporting agents such as water and wind, strongly influences their distribution. In turn, soils and climate are the primary determinants of vegetation distribution.

The geologic map also serves as a direct input to understanding soil and vegetation/wildlife systems. An understanding of geologic trends permits a view of the region as a functioning whole. As with all the other maps suppled herein by NALOD, Inc., the ultimate purpose of the geologic map is to indicate areas suitable for specific activities or long-range development and those areas to be avoided--in other words, to indicate land use opportunities and constraints.

On the Tri-County region map, geologic units of similar character are grouped together in large classifications. Surface deposits are grouped primarily by geomorphic (land form or formation process) type, and bedrock formations are grouped by rock type.

The region is distinguished by a high point, the great massif of Mt. Angel surrounded by ridges and hills of interbedded sedimentary rock. It is among these ridges to the east of the mountain that coal can be found (see figure on next page). The two geologic sections depict two coal seams, each in a different kind of geologic situation: the southernmost coal seam (A) dips sharply under ground and is suitable for shaft mining; the northernmost coal seam (B) is horizontally bedded at shallow depth at its eastern extreme and is suitable for strip mining, whereas its greater depth in its narrow western extent makes it only marginally suited for strip mining.

The stream valleys of the region are generally filled with alluvium which was washed down from the mountains. There are also surface deposits associated with estuarine (river/ocean) processes. Among them are the old bay mud deposits, generally underlying salt marshes, and the basic sediments--once the floor of an ancient land-locked sea.



Location

Location of coal seams on geologic map.
Coal seam Ⓐ → suitable for shaft mining.
Coal seam Ⓑ → suitable for strip mining.

Figure 1.

DATA MAP 3. SLOPE

Slope is an important factor in determining how land is used; steep slopes often place great limitations on development.

Map 3 depicts percent of slope. A ten percent slope, for example, rises ten feet in a hundred horizontal feet. Less than five percent is considered almost level and is suitable for most kinds of development.

Most construction projects entail denuding the site of all of its vegetation: soil erosion on unvegetated sites often increases a hundredfold. Since slope directly contributes to rate of erosion, slopes over 15% are generally considered not suitable for building construction. Costs for site-work increase greatly on steep slopes, the greatest of which may be measures to mitigate the environmental impact of soil erosion and its subsequent clogging of drainage channels and sedimentation of nearby streams. Timber cutting on steep slopes near streams involves many of these same problems. And drainage fields for sewage disposal, as another example, depend on their liquid contents to percolate slowly into the soil; these disposal fields do not function well if sited on slopes over 5%.

Agriculture, with the exception of pasture, vineyards, and sometimes orchards, is a land use most suited to areas with little or no slope (0-5%). It is certainly possible to farm on steep slopes, but again, erosion becomes a problem and contour plowing or terracing is often necessary, at additional trouble and expense to the farmer. Farm machinery also does not operate well on slopes, and not at all over 15%.

DATA MAP 4. SOILS

Chemical and physical properties of soils are very important in the evaluation of carrying capacity and environmental impact. Soil is the medium in which all terrestrial plants grow and provides the foundation support for much of man's construction activity. A glance at the soils map in combination with the matrix gives an idea of the variability of the tri-county region's soils. Their various characteristics are derived from many forces, not the least of which are underlying geology, transporting agents, i.e., wind and water, climate and man's activities. The tri-county region's great reliance on agriculture is largely the result of soils highly suitable for orchards in the Rio Verde Valley and for crops on the broad plain of Flapjack Creek. Most of these rich soils overlie alluvial deposits carried down from the mountains or, in the case of the vast interior valley, the floor of an ancient sea.

The matrix explains the characteristics of each soil type beginning with Parent material, the underlying geologic type from which a soil is formed and which, through the process of weathering, is slowly replaced. The majority of the soils are derived from sedimentary rock or alluvial deposits--which dominate the geology of the region. Symbols used in the map legend are: I-Igneous rock, M-Metamorphic rock, S-Sedimentary rock, and U-Unconsolidated sediments.

Depth to bedrock is an important factor in determining suitability for certain kinds of construction requiring foundations which sit on bedrock. Since much of the region consists of deep unconsolidated deposits, building dams, bridges or other heavy structures presents special problems due to the underlying soils. These are generally the soils shown as having depth to bedrock greater than 60".

Texture is the basic description of a soil and is based on grain size varying from gravel to sand to silt to clay, with many combinations thereof. It is often related to parent material and is the primary detriment of the soil's hydrologic characteristics, foundation bearing capacity, and erodibility. Texture is broken down into six classifications ranging from very coarse to very fine: Sand (S), Gravelly Loam (GL), Sandy Loam or Silt-Loam (SL), Gravelly Clay Loam (GCL), Silty Clay Loam (SCL), and Clay (C).

Depth to seasonally high water table is an important consideration when considering questions of construction (particularly deep foundations and basements) and the siting of septic tanks, sanitary landfills, and other facilities that accompany urban development. It is listed as being less than (-) or more than (+) 60" below ground surface.

Hydrologic soil group is a measure of the soil's ability to transmit water. Aquifer recharge occurs most rapidly through a soil in group A (gravel or sand) and most slowly through a soil in group D (clay, hard pan). The hydrology map combines hydrologic soil and quality of aquifer to determine vulnerability of aquifer.

The erosion potential of a soil (not considering its vegetative cover) is a function of soil texture, structure, porosity, and slope. If a soil contains a high percentage of silt-size particles, is not aggregated and strongly held together, has low porosity, and is found on steep slopes, it will likely have a high water erosion potential.

Erosion potential relates directly to soils' suitability for various types of development. Since construction normally involves denuding a site of its vegetative cover, erosion is frequently a problem. Eroded material often makes its way to the nearest stream causing sedimentation and great biological harm. In urbanizing areas, the harm done to streams by erosion/sedimentation has been called the worst form of water pollution.

Erosion potential is rated from low to high.

1. Low Erosion Potential (L): soils which do not erode easily and where erosion is a problem only on steep slopes where vegetation is removed for long periods. Erosion and sediment control are often not necessary. If controls are needed, standard control measures are almost always effective.
2. Moderate Erosion Potential (M): soils which can be expected to erode if vegetative cover is removed and soil remains exposed for a long period. Erosion and sediment control are necessary. Standard erosion and sediment control measures are often effective.
3. High Erosion Potential (H): soils which can be expected to erode rapidly if vegetative cover is removed. Erosion and sediment control is difficult and expensive.

Allowable Soil Pressure is a measure of the amount of pressure that a soil can support. The foundations of most light structures rest on the soil, and rely on the soil's bearing capacity. Therefore, it is best to locate development in areas where the allowable soil pressure exceeds the weight of the construction contemplated. Otherwise, expensive engineering strategies will be necessary to satisfy building codes and ensure a safe foundation.

The ratings for allowable soil pressure used by the Uniform Building Code are:

1. High Allowable Soil Pressure (H)--soils which can support structures that impose pressures greater than 2,000 pounds per square foot.

2. Moderate Allowable Soil Pressure (M)--Soils which can support structures that impose pressures ranging from 1,000 lbs. per sq. ft. to 2,000 lbs. per sq. ft.
3. Low Allowable Soil Pressure (L)--Soils which can only support structures that impose pressures of 1,000 lbs. per sq. ft. or less.

SOILS: Figure 2.

SOIL FEATURES

MAP UNIT	PARENT MATERIAL	DEPTH TO BEDROCK	TEXTURE	DEPTH TO WATER TABLE	HYDROLOGIC SOIL GROUP	EROSION POTENTIAL	BEARING CAPACITY
Sand	U	0-60"(-)	G	0-60"(-)	A	L	H
A3	U	60"+(+)	GL	60"+(+)	B	M	L
A6	U	+	C	-	D	L	L
C3	U	+	GL	+	B	L	M
C6	U	+	SCL	+	B	L	M
D2	U	+	C	-	D	M	M
E1	S	-	SL	-	B	H	H
E3	U	+	G	+	A	M	M
E4	U	+	G	+	A	M	H
F2	U	+	SCL	+	C	L	M
F6	U	+	C	-	D	M	M
G3-6	U	+	C	+	D	L	M
H11	U	+	GCL	-	D	L	M
H13	U	+	C	-	D	M	M
K2,5	S	-	C	-	D	M	M
K4	S	-	C	-	D	H	M
L1,6	S	-	C	-	C	H	M
N5	S	-	SL	-	C	M	H
P10	I	-	GL	-	D	H	H

DATA MAP 5. HYDROLOGY

Hydrology is the study of water and water features as they relate to the land. The hydrologic cycle is a delicately balanced system powered by gravity, the sun's energy, and man's activities on the land which can have significant effects on water supply, water quality, and aquatic habitats. Therefore, an understanding of hydrology is an important tool in determining an area's carrying capacity.

The hydrology map delineates a number of different water features. The region is well endowed with surface water. The Magella River empties into the Pacific Ocean, and its estuary extends upriver roughly 30 miles and is bordered mainly by tidal salt marsh--the most productive land on earth. These marshes depend on the mixing of salt and fresh water, and their plant and animal inhabitants' health and productivity are directly related to this twice daily tidal exchange. The farther upstream one goes, the more diminished this exchange is until one reaches zero exchange at which point the River is essentially fresh water. The rate of flushing fluctuates naturally with the yearly wet/dry season; any alteration in water supply to the river system, either surface or sub-surface, could drastically affect this flushing.

There are two major tributaries to the Magella River, Rio Verde, and Flapjack Creek. Dominy Reservoir on the headwaters of the latter is a major water supply source for the region, as well as the numerous wells owned by the Tri-County Water District (TCWD). These wells draw water from extensive aquifers (a water-bearing stratum of rock, gravel, or sand), which are mainly the alluvial deposits of the region.

As is mentioned above, much of the region is dependent for its water supply on wells topped into the rich aquifers. The map shows a line marked "under current pumping regime, landward extent of brackish water in the producing aquifer." This statement implies that if pumping increases, particularly near this line, more salt water will flow into the aquifer and the line will move inland, shrinking the producing aquifer. Likewise, if fresh water flushing decreases along the San Tomaso Bay, salt in the water table will move upriver.

The region's aquifers are both extensive and variable in quality. They are unconsolidated deposits ranging from sand dunes to alluvium, and are overlain by soils ranging widely from clay to sand.

The matrix on the map legend ranks four categories of "aquifer recharge/vulnerability of aquifer" based on a combination of hydrologic soil group and quality of aquifer. Class I (darkest) is the most vulnerable; Class IV (lightest) incurs little hazard. Quality of aquifer refers to the water holding capacity of the stratum. The higher the number, the greater its capacity and value as a water supply source. Hydrological soil groups refers to the ability of the soil to pass water through it to the aquifer below. Thus an A soil would be a sand or gravel, and a D would be an impermeable clay or hard pan.

An aquifer is re-supplied with water by a process known as "aquifer recharge." This is part of the hydrologic cycle, returning rainwater to the earth to eventually make its way to streams and rivers, then on to the ocean, eventual evaporation and then condensation in the form of rain. Recharge occurs most effectively when highly permeable soil overlies a high-capacity aquifer. Conversely, this rapid transmission of water to the aquifer has great susceptibility to pollution from septic tank effluent, agricultural fertilizers or cattle excreta, or paved surface runoff containing oil or other impurities, hence the inclusion of "aquifer vulnerability" on the map.

Dominy Reservoir drains a watershed whose boundaries are marked on the map. Any development which could alter the quality of the water entering the stream should be avoided if at all possible.

Marked on the Hydrology Map as potential safety hazards are the tsunami (tidal wave) possibility and the 100 year flood plain. This predicts the extent of flooding in the event of a tsunami (tidal wave)--which could be caused, for example, by an offshore earthquake or hurricane.

An important part of a river system is its flood plain. It is nature's buffer to absorb rising flood waters, and provides storage during periods of high water. Deposited river sediments form the rich alluvial soils of the flood plains. Many of the richest farming areas of the world are on flood plains. The 100-year flood plain is that area which would be inundated during the worst flood expected to occur in a 100-year period; that is, flooding has a 1% chance of occuring in any given year. Flooding in itself is not harmful, but when structures are built on flood plains, damage will occur each time the stream floods. The Tri-County region is presently under a flood plain zoning ordinance mandated by H.U.D. as a prerequisite to federally subsidized flood insurance. Any new building construction on the 100-year flood plain cannot be insured against flood damage, and local government is discouraging it in their planning efforts.

DATA MAP 6. VEGETATION

The tri-county region's great variation in climate, soils, and other environmental factors has produced a diversity of plant communities. Many communities are still in their natural state, though most have felt human hands in one way or another. There are urban areas which are almost entirely human-influenced in their vegetative character; and there are extensive agricultural lands shown in this map by crop type. Plant communities are a basic ecological unit; thus a vegetation map comes close to mapping a region's ecosystems. The presence of a particular plant community is the best indicator of environmental conditions--much can be learned about a place by studying the changes in vegetation over a seemingly homogenous area.

For urban areas, two categories for vegetation are used, urban grassland (UG) which includes golf courses, cemeteries and urban parks, and residential/industrial (RI), encompassing the built-up areas of the regions, but often containing considerable open space, a fact which should not be overlooked.

For agricultural areas, the designations are Ac, Ar, Ao, Av, and As, referring to the major crop. These areas are vital to economic, political, and environmental concerns and decisions; their food production makes them critical in determining the carrying capacity of the region.

A community of indisputably high value to Pacificans is the Coastal Strand and Cliff (referred to as Bea community). The vegetation here is largely succulent, enabling it to withstand decreased fresh water availability, continued salt spray and dessication. Plants included are grasses, sedges, and some small shrubs. The cliffs are largely unvegetated due to active erosion, shallow soil and constant winds. The remaining sand dunes at Lido Beach and further north up the coast are stabilized by a rare and sensitive species of dune grass.

Tidal Wetlands (TW) are the most productive lands on earth, being the nursery for many species of ocean fish and shellfish. Many mud flats and salt marshes similar to those mapped here have already been drained and filled in the tri-county region and throughout Pacifica. Nevertheless, these lands should have highest priority when the question of preservation of natural areas is discussed.

A larger portion of the study area remains in grassland (GR). The composition of this land has radically changed in the past century due to overgrazing. The once perennial bunch grasses have now been replaced by non-native annuals. As a result, these areas are highly fire-prone during the late summer and fall dry period when they die out as they do each year.

Scrub (SCR) is the semi-woody sub-shrub growth which occurs along the coast and occasionally inland. These areas have higher moisture levels and, therefore, are not as fire-prone as either the drier grassland or chaparral.

The dense shrubby vegetation called chaparral (CH) is the dominant community on the east-facing upper elevations of the foothills and Mount Angel.

Broad-leaved woodland (OWD) includes oaks, pines, and other mediterranean-climate wet-winter/dry-summer woodland plants. Where grass savannahs predominate, scattered thinly with pines and oaks, low moisture levels are indicated. With increased moisture, the woodlands become more dense and larger species become dominant.

At higher elevations and in some moist valleys are mixed conifers (MC). These stands of towering firs, pines and some redwoods are the source of the region's timber industry, a major employer. These forests, largely unsettled, have great recreational value as well. They are the region's last wilderness.

Redwoods (RW) once a common tree in the region, have been reduced to a few paltry second growth groves, with notable exception--the John Muir grove, now part of Seagate National Recreation Area. Redwoods grow in deep valleys within the ocean fog belt, somewhat back from the sea as they are not salt or wind-tolerant. These giants are the tallest trees on earth, and once formed an important part of the region's economy. Many of the older houses of the area were built of first growth redwood. Those left now are worthy of preservation for their beauty alone.

DATA MAP 7. SOILS: AGRICULTURE (Suitability for crop production)

The tri-county region is rich in agricultural soils. Crop farming, orchards, vineyards, and pasture are highly important parts of the local economy. The two main agricultural sub-regions within the tri-county region are the Rio Verde Valley, which has long been known for its fruit and nut orchards, and the broad, flat interior valley--the "bread basket of Pacifica." The Flapjack Creek watershed is but a small portion of that valley.

Most of the USDA Class 1 areas are presently in crop production. Those which are not are either urbanized, threatened by urbanization, or in remote sections. On the map, category 1 consists of those soils classed as prime agricultural land by the U.S. Department of Agriculture. Factors considered in the classification system include fertility, workability, degree of erosion, drainage characteristics and slope. Prime agricultural lands satisfy all or almost all of these criteria. Class 2 soils satisfy most of these criteria, but may occur on slight slopes; or they satisfy all fertility/workability criteria but occur on steeper slopes. Class 3 soils are some combination of poor or excessively fast drainage, steep slope, unworkable texture or are in an eroded condition or marginal in fertility. Fertility was the primary criteria in classifying the soils, and all three categories have sufficient fertility to support crops or supply cattle forage. The main differences in the classes suggest degree of cost and effort necessary to achieve levels of production comparable to Class 1 soils.

DATA MAP 8. LAND USE

The tri-county region's land use is as diverse as its physiography. The region was first settled as a seaport, fishing port, agricultural and logging center, and its early settlements reflect this.

San Tomaso, Doeland, and Rio Verde were the earliest settlements, serving the early industries. With the coming of the railroad, Wheat and Murphy's Landing grew; the advent of the automobile led to the proliferation of suburbs such as Levitt Valley, Happy Valley, and Cow Valley, and the highway-oriented development of Strip City.

Lido Beach, Aaron Beach, and Baker's Beach are predominantly recreation-oriented communities.

Most industry is located in and around the older urban settlements and/or in close proximity to transportation facilities, i.e., superhighway, rail, ship, and air. The region's energy needs are supplied by a coal-fired electric power generating plant at Murphy's Landing. Transportation was one of the reasons for the settlement of the region, and it continues to play an important role. Interstate 60, a major cross-country route, terminates at San Tomaso, joining with a freeway south along the coast and north through the Rio Verde Valley. San Tomaso and Doeland are major shipping ports, the latter being equipped with modern container facilities. Central to the region's urban areas is an international airport; the Magella River corridor and San Tomaso with its Pennisula industry is served by the Southern Pacific Railway.

Agriculture is an important land use in the Tri-County Region, with crops ranging from fruit and nuts to rice and grains. Much of the agricultural land is now protected from urban development through a preferential tax assessment under the state's Fatherwill Act. By giving tax relief to working farms, this Act mitigates the threat of urban sprawl, thereby ensuring an ample supply of agricultural land to feed future generations while protecting valuable open space.

Other extractive land uses in the region are logging, which takes place on the Bureau of Land Management lands in Carbon County, and a potentially major coal mining operation.

The tri-county region is well endowed with parks and recreation areas. The National Park Service recently established Seagate Natural Recreation Area, which includes some 30 miles of rugged sea coast and beaches as well as the John Muir Redwood Grove, in close proximity to the urban areas of the region. The U.S. Fish and Game Commission administers the Leopold National Wildlife Refuge and is contemplating purchase of Spartina Break and Brower Marsh, now held by the National Wildlife Conservancy as prime water-habitat. In addition, there are two state parks, Steward Brand and Mount Angel, as well as Odum Ranch State Preserve. Round Valley Regional Wilderness provides a true back-country experience, and there is ample hiking country in all of Northern Carbon County. Sportsmen enjoy duck hunting in the state game lands and Mills Marsh.

DATA MAP 9. HISTORIC, SCENIC, AND ENVIRONMENTALLY SENSITIVE AREAS

The region has a number of ecosystems which are unique in their own right. Some contain rare and endangered plant or animal species; others are examples of biotic communities existing in an undisturbed state. Pacific County is best known for its tidal pools, home to countless intertidal shellfish and invertebrates, and the offshore erosional remnant islands on which sea lions are often sighted. Lido Beach still retains some of its sand dunes, which are stabilized by a rare species of dune grass. Much of the country was once forested in redwood, and several stands still exist, most notably the John Muir Grove. The Magella River estuary includes several large salt marshes--highly productive and valuable as a fish and wildlife habitat. Salt marshes also perform a vital service by improving the quality of water which passes through them.

Due to the relatively high altitude combined with its proximity to the ocean, Angel Mountain's slopes are home to a number of plant and animal species not found elsewhere, including the only nesting sites of the Peterson's Hawk south of the Canadian border.

Odum Ranch exists as a monument to its original owner, Jeremiah Odum, who so likened it to his Old World birthplace that he decreed that it should be preserved in its natural state in perpetuity. It is an incomparably pristine valley grassland ecosystem of some 10,000 acres. Round Valley Regional Wilderness was recently set aside, and it promises to provide a back-country experience (no vehicles are permitted) to all who visit, assuming they heed the credo, "Leave only footsteps, take only memories." The Tri-County Regional Parks District is presently developing a permit system to assure that Round Valley's use levels and their impact can be monitored.

The region is well known as a place of scenic beauty. The view from atop Mountain Angel is said to be surpassed only by Mt. Kilimanjaro in Africa for its long views in every direction. One can see through the mouth of San Tomaso Bay to the west, and 100 miles east to the peaks of the Snow Mountain Range. Views to the coast from the rugged summit are enjoyed by millions of tourists every year. The map marks the ocean "view-shed", or that area west of Mt. Angel from which the Pacific Ocean can be seen. Most of this as yet unsullied view from Mt. Angel is largely over private land.

The area has significant historic sites, all the more valuable because much of the region was devastated by the 1922 earthquake. Those sites which remain are Mission San Tomaso, where the first Spanish Settlement took place in 1783, The Seaport Historic district in Doeland which dates back to the late 19th century, and Odum Ranch Hacienda which was built in 1806. Each of these sites are reminders of important aspects of the region's early history and are a significant aesthetic and cultural resource.

North of Port O'Connell is a newly-discovered Mirok Indian village site. Archaeological investigations have only recently begun, but early findings indicate that much can be learned here about the early life of this now-extinct tribe. Professor Greeky of the University of Pacifica at Rio Verde has stated, "We have here a chance to study a village site which for some as-yet-unexplained reason was abandoned almost intact. This site offers us a clearer, more complete picture of early man than any site I have previously encountered."

MASTER MATRIX

of Intrinsic Land Suitability

Suitability "FACTORS"	Nature	Nature / Human	Human
Data Map for	PROTECTION (Blue or Green)	AGRICULTURE (Black)	URBAN (Red or Orange)
3. SLOPE (Orange)	25% +	0-5%	0-15%
4. SOILS (Brown)			
• Fertility	-	High	-
• Depth to Watertable	0-60" (-)	-	60" + (+)
• Erosion Potential	High (H)	Low	Low
• Bearing Capacity	-	-	High
5. HYDROLOGY (Blue)	• Tsunami hazard • 100-year flood flood plain • Reservoir water-shed • Vulnerable aquifer (I, II)	-	-
8. LAND USE (Red)	• Fatherwill ▨ Act • Public owned open space (Pu)	-	• Urban (R/C, I, R)
9. HISTORIC, SCENIC, SENSITIVE (Green)	• Sensitive eco-system • Archeological site • Historic site • Short view • Long view • Viewshed • Scenic road	-	-

NOTES: ON THE MASTER MATRIX

The Master Matrix displays the basic data you will be working with in developing your carrying capacity analysis of the Tri-County Region.

The columns display the three types of land suitability you will need to determine (actually, you will need to determine only two of these--protection suitability and urban suitability--since agriculture suitability has already been done for you).

The rows display the basic data maps you will be using to develop the three (in this case, two) types of suitability determinations.

The smaller boxes (or cells) within the matrix display the factors and factor values associated with each data map and relevant to each type of land suitability.

Suitability for Agriculture

The "Soils: Agriculture" map (map #7) delineates areas suitable for crop production and represents a synthesis of factors derived from the SLOPE and SOILS data maps. Since this map has already been completed for you, the Task Force needs to address the other two land suitability areas of Urban and Protection, two uses which are usually, but not always, mutually exclusive.

Suitability for Protection

Most of the criteria for Protection are aimed at enhancing the ecological diversity and productivity of the region while protecting those areas which are sensitive to man's intrusion. Particularly important to the Tri-County region is the maintenance of its water quality (through respect for the hydrologic cycle), retention of its scenic qualities as well as historic sites, preservation of its unique plant and wildlife habitats, and the maintenance of the region's agricultural character and food production.

More specifically, respect for the hydrologic cycle suggests that the aquifers which supply groundwater should be protected and that stream corridors should remain undeveloped. Erosion is the most serious form of water pollution in urbanizing areas--not because of poisons it carries into streams, but because of the damage suffered by aquatic habitats when silt enters them. Construction is often accompanied by erosion, and erosion is related to slope; hence we suggest steep slopes be protected from construction, especially near streams. Wastes from septic tanks will often pollute groundwater if they are built in areas with a high water table or excessive soil permeability. This situation often exists near stream channels, so it is suggested that septic tanks be forbidden within 150 feet of all surface waters. Groundwater supply and quality are best protected by limiting development over areas of high aquifer (an aquifer is a water-bearing stratum of rock) recharge value (one and the same as vulnerable aquifers). Certainly septic tanks should be prohibited on areas of "Class I" and "Class II" aquifer vulnerability." Other areas already protected from development are publicly-owned spaces and Fatherwill Act lands.

Suitability for Urban (land use)

Suitability for urban land use is a more complex problem. In general, the most suitable areas for building in the Tri-County region are in the vicinity of those which are already urbanized. The best way to prevent urban sprawl is to confine new development to these areas. Transportation and utility networks already exist, and less energy is consumed in getting from place to place when urban development remains centralized.

The best lands for urban use are flat or nearly so, on stable, well-drained soils with good bearing capacity. Aquifer recharge areas should be avoided, particularly for the kind of development which involves large expanses of pavement because they do not allow infiltration of water into the ground, but instead channel it into storm sewers and on to streams and rivers. This periodic sudden runoff causes a "flashy" pattern of floods and droughts, i.e., wild fluctuation in stream flows accompanied by increased bank erosion and rapidly deteriorating fish habitat. This problem is so serious that some localities have actually adopted "zero runoff ordinances" which prohibit any surface water from leaving one's property. Of course, all urban development should avoid flood plains, tsunami hazard areas, and the recharge area of Dominy reservoir. The water that runs off from pavement normally infiltrates into the ground, replenishing aquifers and slowly making its way as groundwater to stream channels. Under normal conditions, this maintains stream flow at a relatively stable level.

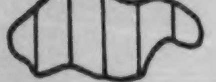
FACILITATING NOTES

Re: the synthesis of 9 base maps into 3 suitability maps --

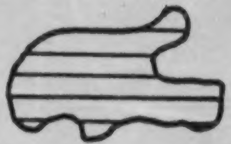
1. Teachers should divide up into two groups--the first group to develop the PROTECTION suitability map, and the second group the URBAN suitability map. The AGRICULTURE suitability map has already been completed for you (see map #7).

2. When preparing base maps for tracing paper overlays, tape down only the corners of each to facilitate the frequent untaping and re-taping required to develop your composite and overall analysis maps.

3. Make up your own fill lines, e.g.,



or

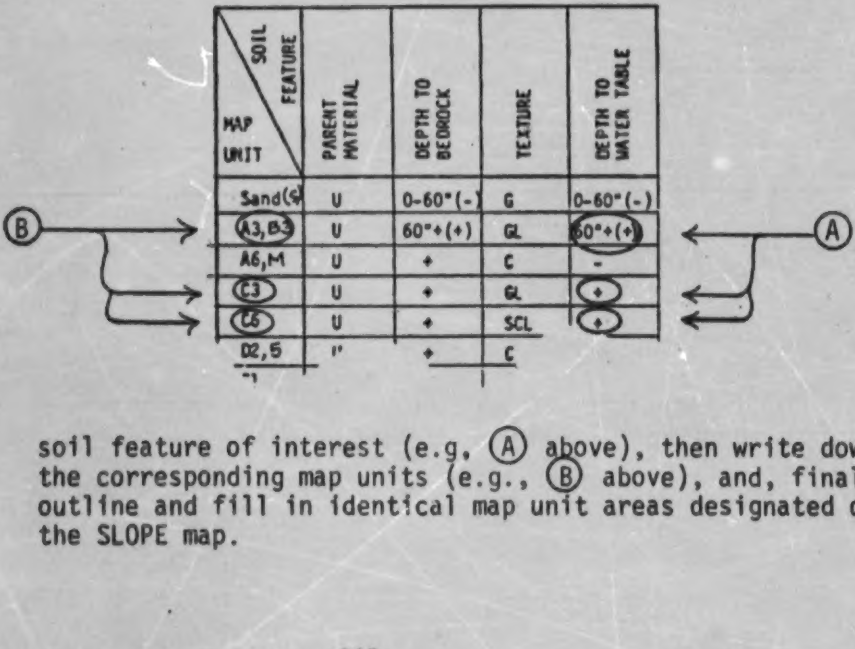


,

etc., when none are indicated in the map legends.

4. For the URBAN suitability map, when analyzing the SLOPE base map (#3), line in all areas which are between 0-15° (do not draw any distinctions between 0-5° and 5-15°).

5. When analyzing the SOILS map (#4), first locate the

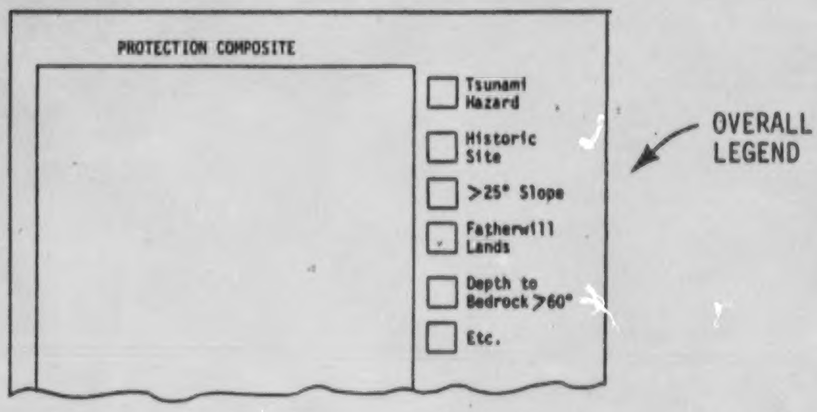


MAP UNIT \ SOIL FEATURE	PARENT MATERIAL	DEPTH TO BEDROCK	TEXTURE	DEPTH TO WATER TABLE
Sand(S	U	0-60"(-)	G	0-60"(-)
A3,B3	U	60"+(+)	GL	60"+(+)
A6,M	U	+	C	-
C3	U	+	GL	+
C5	U	+	SCL	+
D2,5	"	+	C	

soil feature of interest (e.g. Ⓐ above), then write down the corresponding map units (e.g., Ⓑ above), and, finally, outline and fill in identical map unit areas designated on the SLOPE map.

Re: the development of 3 composite maps --

6. For each composite map, it may facilitate the process of assigning degrees of land use values (e.g., for PROTECTION-- inviolate ▩, very sensitive ▦, desirable ▥) by making an overall legend that combines all the separate base map legends. For example:



OVERALL LEGEND

7. On the URBAN COMPOSITE map, outline in pencil all areas already built on (towns) for later identification and analysis in developing the OVERALL LAND USE map. This will help you to determine, for example, what (human) communities might be affected by runoff from strip mining operations.

IMPORTANT 8. Make certain you draw on the coal deposit locations A and B on each of the COMPOSITE maps (Protection, Urban, Agriculture). These can be located on the GEOLOGY map (#2) and from the figure in the GEOLOGY map description (p.).

Re: the development of the land use report --

9. The report should identify any major problems, issues, and considerations for which there are no data or which need to be answered or analyzed further regarding land use in the Tri-County Region and, specifically, the proposed coal mining operations. MOTTO: If we can't resolve the problem we can at least identify what it is.

10. Study carefully the HINTS and EXAMPLE REPORT (pp.) before developing your report.

MAPPING AND CARRYING CAPACITY
ANALYSIS INSTRUCTIONS

Materials needed:

- Set of colored pencils or pens (an extra set will be helpful)
- roll of tracing paper or a pad of tracing paper, 12" x 17"
- roll of "masking" or "drafting" tape

To develop maps of intrinsic suitability for Protection and Urban land use, you will need to synthesize or combine appropriate factors information from each of the data maps indicated in the Master Matrix. These synthesized or composite maps will indicate those areas in the Tri-County Region that are optimal or ideal for their respective land uses. Once these have been developed, you will then need to overlay and evaluate these synthesized or composite maps in order to develop an overall map for the Tri-County Region. This overall map should designate specific areas or sites for (1) urban growth and development (including the coal mining operations), (2) crop production, and (3) protection of wildlife, scenery, historical landmarks, etc.

A. Developing the PROTECTION Suitability Maps

When completed, these maps will constitute the bases for developing a synthesis or composite of all relevant factors from each data map indicated in the Master Matrix, i.e., SLOPE, HYDROLOGY, LAND USE, ~~and~~ HISTORIC, SCENIC, SENSITIVE AREAS.

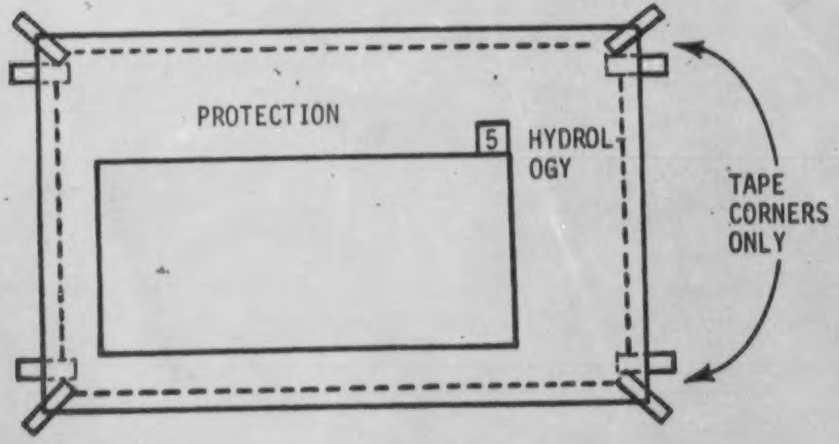
1. Using a set of colored pencils or pens (we recommend pencils because mistakes are easier to erase), assign a specific color to each of the data maps listed in the Master Matrix. (rows).

   For example:

Map No.	Data		Color
3	SLOPE	--	Yellow or Gold
4	SOILS	--	Brown
5	HYDROLOGY	--	Blue
8	LAND USE	--	Orange or Red
9	HISTORIC, SCENIC SENSITIVE	--	Green

2. Taking, as an example entry point, the factors associated with the PROTECTION - HYDROLOGY cell, first select and tape the corners of the HYDROLOGY map (#5) to a flat, smooth surface.

3. Take a sheet of tracing paper (at least 12" x 17") and tape it (corners again) over the HYDROLOGY map; then carefully trace over each of the heavy outside border lines, the title of the map, and write the word PROTECTION outside the border. Use a heavy black fine-tipped felt marker or pen for these tasks.

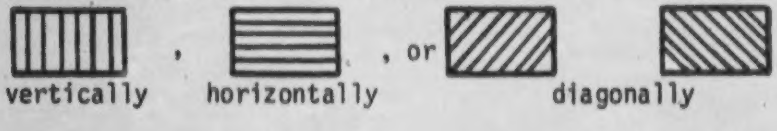


The border lines are your "registration marks" which will enable you to precisely align the various sheets of tracing paper you will use to develop the composite map.

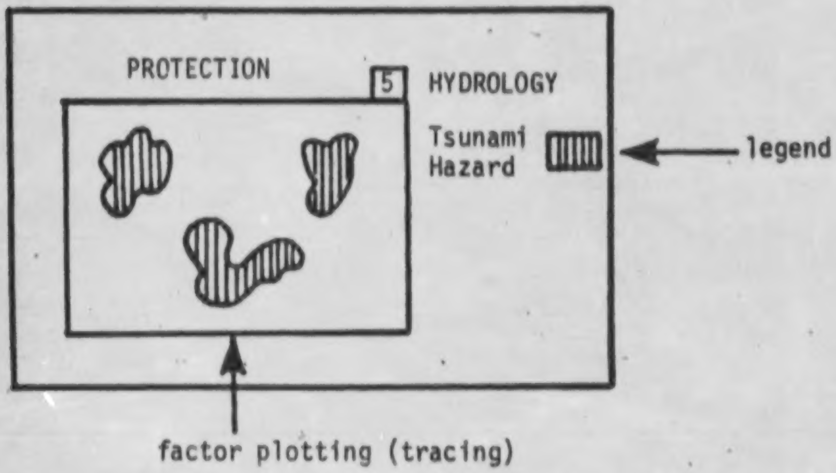
4. Next, with the appropriate colored pencil (blue, in the case of HYDROLOGY), trace the outline of all areas on the map associated with the first factor -- "tsunami hazard" (see Master Matrix).

   Also trace the legend entry associated with this factor on the right side of the map and label it: "TSUNAMI HAZARD."

   At this point, you should fill in the outlined areas of the map with the same cross-hatching as indicated in the legend, e.g.,

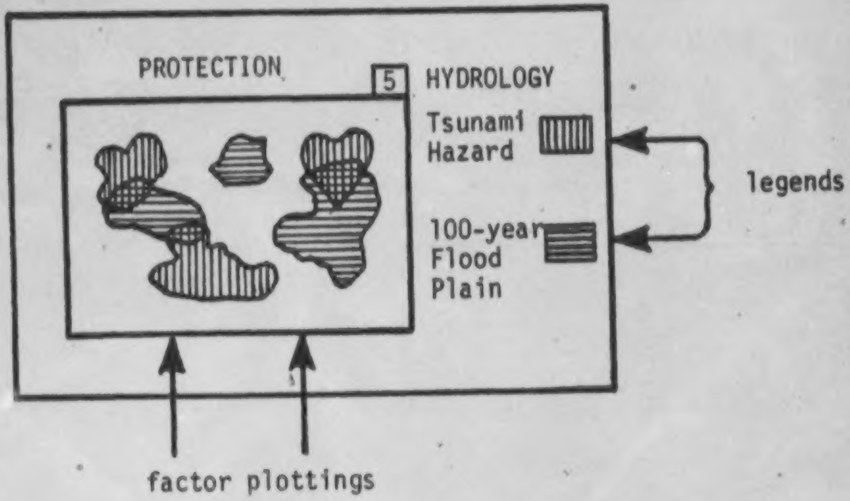

,
, or
vertically
horizontally
diagonally

   If no cross-hatching is indicated, then make one up, as long as it differs from the cross-hatchings associated with all other factors on this data map.


PROTECTION
5
HYDROLOGY
Tsunami
Hazard
legend
factor plotting (tracing)

5. Now proceed to the next factor, "100-year flood plain," and trace or plot it out the same way you did for the first factor. Use the same colored pencil (i.e., blue) and make certain to fill in the map outlines for this factor with the appropriate cross-hatching indicated in the legend or make one up (e.g., ▤).

Also mark and label the legend so you will know what the cross-hatching means.



Do not worry about overlapping of cross-hatchings as this is precisely what should be occurring.

REMEMBER: As more factors are mapped, and more overlapping of the cross-hatching occurs, the DARKER become those areas MOST SUITABLE for the particular type of land use--in this case, HYDROLOGY PROTECTION.

6. Repeat the above procedures for each of the remaining factors within the HYDROLOGY - PROTECTION cell of the Master Matrix until all factors are plotted.

7. Once you have plotted all factors off one data map (one box or cell within the Master Matrix), remove the tracing paper from the map and place it aside for the time being. Then go to the next data map indicated in the Master Matrix, e.g., SOILS, tape it down as before, and place a fresh sheet of tracing paper over it.

   After taping down the tracing paper, outlining the map borders, and properly labelling the map (e.g., PROTECTION: SOILS) with a black pen or fine-tipped felt marker, proceed to plot or trace out each of the factors indicated in the Master Matrix for the SOILS x PROTECTION cell (i.e., "depth to watertable" and "erosion potential"). Use the appropriate colored pencil (e.g., brown) to complete all tracings.

8. Repeat the above procedures for each of the remaining data maps and sets of factors indicated in the Master Matrix under the PROTECTION column. Always remember to use the appropriate colored pencils [i.e., SLOPE (yellow or gold), LAND USE (red or orange), and HISTORIC, SCENIC, SENSITIVE AREAS (green)].

When complete, you should have five (5) different tracing maps for this land use suitability area. These should be placed aside for the time being while you proceed on to the next suitability area: URBAN land use.

B. Developing the URBAN Suitability Maps

Follow the same procedures as described in steps #1 - #8 above; only, in this case, you will be plotting (tracing) out the factors from only three (3) data maps, i.e., SLOPE, SOILS, and LAND USE (see Master Matrix).

C. Developing the AGRICULTURE Suitability Maps

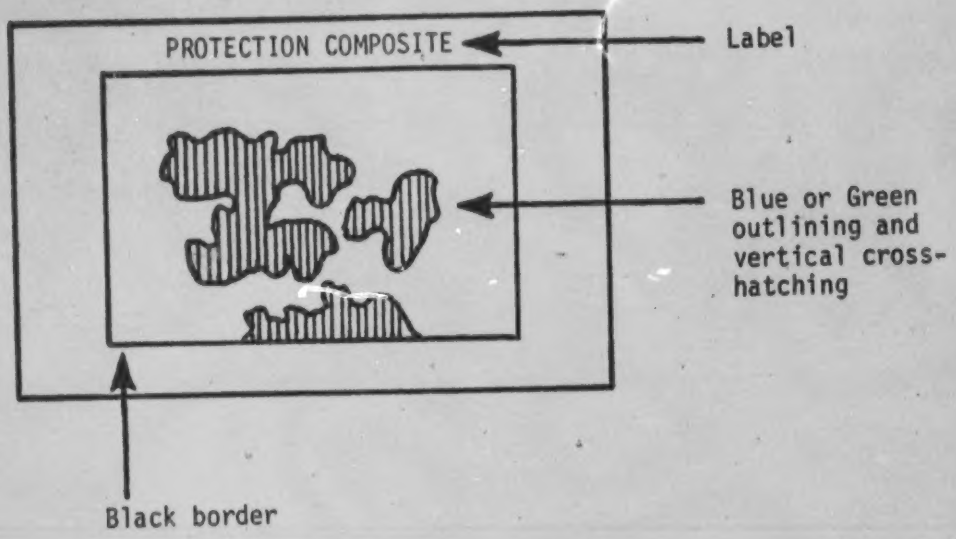
The composite of these maps have already been completed for you (see SOILS: AGRICULTURE map #7).

D. Developing the Composite Land Use Maps

The composite maps will constitute the basis for developing an overall land use map and a set of recommendations regarding the specific areas in the Tri-County Region which will be designated for urban development, agricultural use, and protection. This overall land use will be developed from three (3) composite maps which you will now make from combinations of the suitability tracing maps.

1. In order to make the first composite, assemble all five (5) of the PROTECTION suitability tracings and overlay them, one on top of the other, taking care to align them carefully along the "registration" borders of each map. Tape the corners of each map as you overlay and align it so as to secure it firmly. This can be done against a window to help you to see through the tracings better.
2. Over the aligned tracings, lay a fresh sheet of tracing paper, trace a border, and label your map as before. The label should read: PROTECTION COMPOSITE.
3. Next, trace around all overlapping and non-overlapping cross-hatched areas with a colored pencil or pen. You may use the following color and cross-hatching scheme for this and the remaining composits:
    - PROTECTION composite -- Blue or Green ▥
    - AGRICULTURE composite -- Black ▤
    - URBAN composite -- Red or Orange ▧

As before, cross-hatch in all outlined areas of the map using wide or broad vertical lines as indicated. It is recommended that you use a ruler here so that these lines will be as neat as possible.



4. Once you have completed the PROTECTION composite, proceed on to the second composite. This will require you to assemble, overlay, and align all three (3) of the URBAN suitability tracings in the same manner as described above. Label this map: URBAN COMPOSITE, and outline and cross-hatch with wide or broad diagonal lines using red or orange colored pencil as indicated.

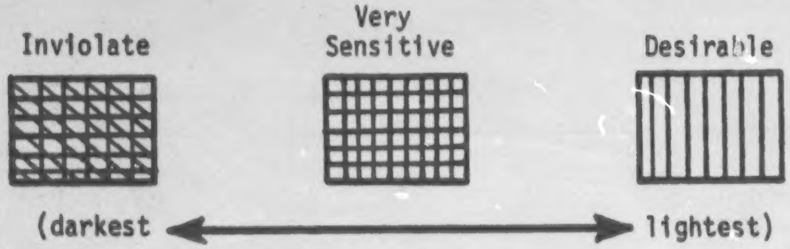
5. The third composite map has already been completed for you (see SOILS: AGRICULTURE map #7). You need only standardize this map with the previous two in the usual fashion: overlay a fresh sheet of tracing paper, border and label it: AGRICULTURE COMPOSITE, outline and cross-hatch with wide or broad horizontal lines using black colored pencil as indicated.

E. Developing the Overall Land Use Map

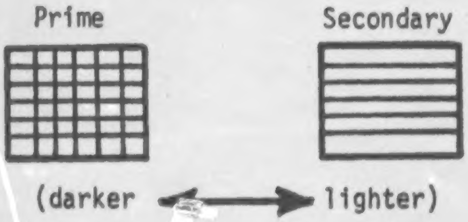
Once you have completed the composite maps, you are now ready to develop the overall and final map which will be the basis for your carrying capacity assessment and recommendations for the Tri-County Region.

1. To begin, you should overlay, align, and tape each composite map as described in previous steps. Taping these to a well lighted window will aid you in the visual aspects of this task. Over these three maps, lay a fresh sheet of tracing paper, draw borders, and label it: OVERALL LAND USE. In the legend area, mark the following:

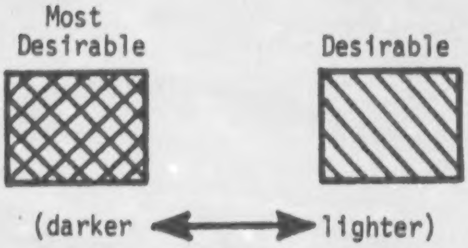
- PROTECTION -- Blue or Green


Inviolate
Very Sensitive
Desirable
(darkest
lightest)

- AGRICULTURE -- Black


Prime
Secondary
(darker
lighter)

- URBAN -- Red or Orange


Most Desirable
Desirable
(darker
lighter)

2. Without outlining the "factors" areas of the map for the time being, examine, as a group, the overlapping and non-overlapping portions of the composites and discuss your observations. This will help to give you an initial idea of where the overlapping and non-overlapping land use areas of the Tri-County Region are. You will probably notice that most of the Tri-County Region land areas seem to be well suited for protection.

   - Note the location of the coal deposits and what types of single or multiple land uses (protection, agriculture, urban) overlap these deposits.

   - Note which areas you could designate right now for solely PROTECTION or AGRICULTURE or URBAN use and which involve multiple use potential.

You must now decide, as a group, on how you will designate or recommend each area of the Tri-County Region in terms of its value for protection, urban development, or agricultural use. Keep in mind that MULTIPLE USES may also be possible or necessary.

You will find this task to be the most "integrating" (and the most fun) since it requires you to utilize all your present knowledge and understanding of land use and involves much discussion, debate--and exchange of facts and data--regarding tradeoffs between available land and multiple or conflicting land use needs.

3. To facilitate the decision-making task, you should first disassemble the three composites and overall maps, and, taking each composite map in turn, apply the appropriate set of ratings or cross-hatchings indicated in the overall map legend (see previous step #1).

IMPORTANT ⇨ As a general rule-of-thumb, assign the highest land use ratings (i.e., inviolate or primary or most desirable) to the darkest (cross-hatched) areas of each composite map.

If there is some controversy in doing this, you should re-examine your previous tracings, the data maps and their explanations, the module text, or the readings for useful information and data to help achieve a resolution.

4. Once the Task Force has cross-hatched each composite map to indicate its degree of land use value for Protection (inviolate, very sensitive, desirable), Agricultural (primary, secondary), and Urban (most desirable, desirable), re-overlay and align the composites and overall maps (again, against a well lighted window).

5. You should now re-examine and discuss the overlapping and discrete areas of the composite maps in order to reach final decisions regarding the designation of PROTECTION, AGRICULTURE, and URBAN areas. As before, you should utilize previous information from tracings, data maps and map explanations (pp. 220-244) or readings to help you in these decisions.

6. Once you have examined the tradeoffs and made these decisions, outline the areas so designated on the map and fill in with appropriate cross-hatching as indicated in step #1. Be certain to outline each Protection, Agriculture, and Urban area using the appropriate colored pencil (or pen) also.

7. When you have completed the overall map, you will be ready to write-up your Tri-County Region land use recommendations in your report to the Planning Commission (see the Commissioner's letter for details, and the Environmental Impact Checklist for other possible inclusions).

To repeat, your task now is to decide which Tri-County areas that you have initially designated as ideal for protection, agricultural, or urban use are "in conflict with" the coal deposit locations.

Once this is seen on the composite and overall maps, and the Commissioner's questions considered, you can then decide on where the "tradeoffs" or compromises have to be made in redesignating the land for particular uses and for specifying these uses in your report.

HINTS:

- As distinctly as possible, section off four types of areas on the overall map -- agricultural use only, protection only, urban use only, and multiple uses.
- Then, analyzing the overall maps, try to answer the Commissioner's questions (p. 186) for example, will the designated agricultural area supply enough food for the total projected population for the Tri-County Region? What additional areas if any, need to be allocated for urban development? Etc.
- Note that the Commissioner's questions should be the basis for determining which areas are finally designated for protection, and for urban and agricultural uses.
- The substance of your Tri-County Region land use recommendations report can be written up in outline form, in prose, or a combination of the two -- whatever is convenient, although you can organize this report in any manner you deem suitable. For the sake of simplicity, it is recommended that you use headings and sub-headings which are equivalent to the Commissioner's question/analysis areas and to any useful Environmental Checklist categories (p. 214).

EXAMPLE REPORT
Land Use Task Force:
Report to Commissioner Detweiler
Tri-County Regional Planning Commission

TOPIC: Recommendations regarding the desirability of allowing the Madison Mining Corporation coal mining operations to begin in the Tri-County Region.

A. Development potential of the Tri-County Region
   1. Agricultural land and production
      . Crop production potential
   2. Available urban land
      . Energy required to support projected population increase--electricity, water, food, etc.
   3. Important protection and "non-productive" areas (specific)
   4. Sources for supplying projected energy needs
      . Net energy gains (if any) from coal
      . Agricultural produce
      . Other

B. Coal mining regulations and restrictions
   1. Types of mining allowed
   2. Plant site location(s)
   3. Pollution and waste controls required--water, land, air, animal life
   4. Visual impacts or changes to entire area/specific areas
   5. Land reclamation requirements--specific areas
   6. Other

C. Urban siting and expansion possibilities
   1. Most suitable locations for present and future urban development
      a) water supply
      b) sewage
      c) transportation
      d) etc.
   2. Recreational development locations
   3. Multiple use possibilities

D. Aesthetic implications of projected mining operations and population growth
   1. Strip mining devastation to specific agricultural, urban, and protection areas--reparable/non-reparable
   2. Ruined scenic areas, historical sites, etc.
   3. Energy required to restore damaged areas
   4. Long term social effects before and after coal runs out
      a) jobs
      b) goods and services/amenities
      c) pollution
      d) open space and scenic beauty
      e) etc.

In filling in the above headings and sub-headings, you can:
   (a) make recommendations
   (b) indicate still-to-be-answered questions
   (c) indicate new areas for further study

Before proceeding with the APPLICATION, it may be useful as a group to review the goals and objectives for the INQUIRY and INTEGRATION.

Having completed these two, you should understand and be able to:

(10) Apply the knowledge you acquired in the INQUIRY for an assessment of a region's capacity for growth and development.

The APPLICATION presents activities and a set of guidelines for planning and implementing instructional programs on the Optimal Use of Finite Land Resources

APPLICATION

APPLICATION

This APPLICATION provides you with an opportunity to plan an environmental instructional unit(s) or lesson(s) for classroom use which are holistic, transdisciplinary, and issue-focused. The APPLICATION, then, constitutes an exercise in designing a learning experience or set of experiences which raises students' levels of awareness and understanding of The Optimal Use of Finite Land Resources.

The APPLICATION in two sections presents:

The Environmental Problem Context--this section describes the general characteristics of an environmental problem or issue as the primary focus for an instructional unit or lesson.

Checklist for Planning Environmental/Energy-Focused Instructional Units or Lessons--

This section presents guideline questions for planning and developing environmental problem-focused instructional materials and activities.

After completing the APPLICATION section, you should:

(G) Have a familiarity with the components of an environmental problem or issue context, and experience in planning holistic environmental education instruction and learning for students.

1. You should begin by reading through the entire APPLICATION (The Appendices are optional).

2. If the group feels the need to agree upon a definition of environmental education (EE) before beginning the instructional planning process, you can start by reviewing the definition provided in the PREFACE, page xi. You should be aware that EE can also be thought of as:

    - the study of everything--nature, humankind, all disciplines and fields of knowledge;
    - the study of human beings' interaction with nature (the biosphere);
    - the study of the relationships between nature and human systems; and
    - the study of reciprocal or optimal ways to manage the relationships between natural and human systems.

3. "Warm up" to the planning process by discussing and selecting some aspects of Optimal Use of Finite Land Resources which interest you and might interest your students. Consider how the environmental problem issue of land use relates to your own professional subject area. For example, you might start the planning task by identifying land use topics, concepts, and principles which are compatible with your subject area; the possibilities might include: human-nature interactions, net energy and energy quality, cycles, world views, social and economic constraints, etc.

4. Keep in mind that, when planning the student learning activities, the ultimate goal of the instructional plan is to develop in students a level of awareness and understanding regarding urban growth that approaches the level you and the other teachers achieved after completing the INQUIRY and INTEGRATION materials.

5. You can begin planning an environmental instructional unit or lesson for your students by using:

    - the contextual map you developed in the Activity; and
    - the checklist to ensure the adequacy of your instructional plan.

6. Remember, you can utilize the planning checklist in any one of the three ways recommended on p. 280.

7. You can create a unit plan in one of the following ways (whichever is the most comfortable for you):

   - Work individually at first; then share and refine your ideas and plans in a group discussion.
   - Work with another person at first, then share and refine your ideas and plans in a whole group discussion.
   - Work in a whole group to develop a common plan which each teacher can live with and carry out in his/her classroom.

   You should find these group discussions most helpful in: (a) sharing ideas and suggestions, and (b) developing a common set of "notes" which can be used subsequently to select specific instructional materials from or to develop more detailed, classroom-ready environmental, energy-focused activities for your students.

8. You should set a specific time limit (1 week, 3 weeks, 6 weeks, etc.) for your unit--even though this time limit may be changed later--since doing so will help provide you with some concrete limits within which to plan student learning experiences.

9. Remember to specify a particular setting (local, state, regional, etc.) and problem focus in which you might want your students to examine land use topics, concepts, and principles.

10. If you and the other teachers have developed individual instructional plans, go over them in a group discussion and compare them with the guidelines in the checklist. In particular, you should make certain that your plans are specific regarding:

    - the problem context--including topics, concepts, processes that will be covered or utilized (Note: these should address at least some of the topic-and process-oriented contents identified on p. 271.
    - instructional aims or learning objectives;
    - learning resources (readings, people, exercises/activities);
    - evaluation criteria and procedures;
    - time schedule or sequence for learning activities.

11. Do not avoid this planning activity on the basis of your intention or desire to later explore with your students some land use problem/topic areas compatible with their interests. You will find that your initial planning efforts, though tentative, will pay off by better helping you to prepare for implementing environmental education in your classroom.

The Module's Goals and Objectives Chart follows. Only those goals and objectives relevant to information presented in the APPLICATION are highlighted.

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BEING SHIPPED TO EDRS FOR FILMING DUE TO
POOR REPRODUCIBILITY OF ORIGINAL.

SECTION 1

THE ENVIRONMENTAL PROBLEM CONTEXT

After completing this section, you should:

(11) Be familiar with the basic characteristics of an environmental problem or issue.

Before beginning the instructional planning process, it is useful to examine those aspects of an environmental, energy-focused problem context considered by curriculum designers to be suitable for increasing students' broad understanding of energy and environmental problems and issues.

An environmental problem context which is suitable or appropriate for students must involve the following:

a. An issue of national priority

b. A setting of environmental interest

c. Topic/process oriented content

d. A contextual map

A MAJOR GOAL OF ENVIRONMENTAL EDUCATION IS TO DEVELOP IN LEARNERS AN AWARENESS AND BROAD UNDERSTANDING OF ISSUES OF NATIONAL PRIORITY

a. An issue of national priority represents a major environmental issue or problem which is or should be of concern to our national, state, and local leaders...and to citizens in general. Such an issue is broad in impact and complex in nature. Resolution of the issue involves an ongoing process of making and changing policies, regulations, and legislation, and of altering personal values and lifestyles.

In general, an environmental, energy-focused issue of national priority arises from what might be called the "new scarcity" which reflects our approaching the finite planetary limits of: fossil fuels and strategic minerals; natural fresh water; food-productive, arable land; habitable surface area; waste-absorptive capacity of the natural environment; and resilience of the planet's life-support ecosystems.

Examples of issues of national priority which address these "new scarcity" areas are:

- energy resource delivery and use
- energy conserving resource utilization
- optimal use of finite land resources
- energy-intensive urban growth and the quality of life

A MAJOR CONCERN OF ENVIRONMENTAL EDUCATION IS TO DEVELOP IN LEARNERS AN UNDERSTANDING OF ISSUES OF NATIONAL PRIORITY AS THEY OCCUR IN A VARIETY OF SETTINGS.

b. A setting of environmental interest provides a milieu or frame of reference for focusing on and setting boundaries for the study of an environmental or energy issue of national priority. This setting can be specified in a variety of ways according to:

(1) Natural systems boundaries

- Aquasphere (oceans, lakes, rivers, streams, marshes, aquifers, etc.)
- Lithosphere (mountains, plains, forests, woodlands, deserts, etc.)
- Atmosphere (rainfall, winds, temperatures, sunlight, etc.)

(2) Human systems boundaries[1]

- Shelters (housing, community facilities, city centers)
- Networks (public utility systems, transportation systems, communication systems)
- Individual (physiological needs, safety and security, affection, belonging, esteem, self-actualization, knowledge, aesthetics)
- Society (government systems, legal systems, economic systems, political systems, cultural patterns, population trends, health and welfare systems)

(3) Geographical-political boundaries

- Local, county level of focus
- Multi-county, state level of focus

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[1] Adapted from Ekistics, Vol. 41, No. 246, May, 1976, pp. 257-262.

- Multi-state, regional level of focus
- National level of focus
- International, global level of focus

An example of an issue of national priority specified in terms of a setting of environmental interest is: the impact of proposed coal mining operations on the Tri-County Region (geographical-political setting).

c. Topic and process areas provide important focus points for selecting and organizing learning resources to study environmental and energy issues of national priority within specific settings.

A CENTRAL CONCERN OF ENVIRONMENTAL EDUCATION IS TO DEVELOP IN LEARNERS AN UNDERSTANDING OF THE IMPACTS AND INTERRELATIONSHIPS OF VARIOUS TOPIC AREAS AS THEY ADDRESS ISSUES OF NATIONAL PRIORITY OCCURING IN SPECIFIC SETTINGS.

(1) Key topics provide the learner with a variety of convenient areas[1] for studying an environmental/energy issue of national priority. These areas are so interrelated with respect to environmental issues in general that an entry investigation of one area leads, in most cases, to an investigation of the others as well.

The key topic areas include:

TOPIC ORIENTED

- Population dynamics
- Pollution
- Resource allocation and depletion
- Conservation
- Transportation
- Technology
- Urban and rural planning
- Environmental quality
- Ecological balance
- Natural resource related careers and vocations
- Economic and technological development
- Environmental ethics

---

[1] All but the last three of these have been designated by the Environmental Education Act, Public Law 91-516 (as amended by P. L. 93-278) as areas of major importance in environmental education. The last three have been added by the developers of this module.

A MAJOR CONCERN OF ENVIRONMENTAL EDUCATION IS TO DEVELOP IN LEARNERS AN UNDERSTANDING OF AND FACILITY IN APPLYING PROCESSES IN STUDYING ISSUES OF NATIONAL PRIORITY WITHIN SPECIFIED SETTINGS.

(2) Key processes provide the learner with useful conceptual and analytic entry points for studying any issue of national priority in any setting. These processes do not conflict with, but instead complement, the topic oriented entry points specified previously.

The key processes include:

PROCESS ORIENTED

- Analytical or conceptual tools for understanding energy and environmental systems
- Problem-solving and decision-making strategies
- Holistic lifestyle assessment
- Fundamental concepts and principles of energy (energetics)
- Energy delivery systems and processes
- Forecasting, planning, and policy formation
- Futures thinking

Examples of topic and process oriented content which might be studied in the example situation of investigating the impact of coal mining on the Tri-County Region (setting) are:

TOPIC ORIENTED CONTENT

Projected population growth and increased demands for resources (population dynamics, resource allocation and depletion)

Increased pollution and long term environmental health problems (pollution, environmental quality)

PROCESS ORIENTED CONTENT

Carrying capacity analysis as a basis for decision-making (problem-solving and decision-making strategies)

Net energy costs and benefits involved in coal mining operations (energy delivery systems and processes).

YOU SHOULD NOW BE FAMILIAR WITH THE BASIC CHARACTERISTICS OF AN ENVIRONMENTAL, ENERGY-FOCUSED PROBLEM CONTEXT--SPECIFICALLY ADDRESSING:

- AN ISSUE OF NATIONAL PRIORITY
- IN A SETTING OF ENVIRONMENTAL INTEREST
- WITH TOPIC/PROCESS ORIENTED CONTENT

In the section which follows, the problem context becomes the basis for your planning an environmental energy-focused instructional unit(s) or lesson(s) for your students.

d. The Contextual Map

In order to identify the key topics, concepts and principles which constitute the "territory" of land use problems and issues, we have developed--as a design tool--the notion of a contextual map. This map shows not only the relevant topic areas, but also demonstrates the relationships of the content. It ensures that the problem area is presented in terms of both natural and human systems considerations as well as the interactions between the systems. This contextual map is useful as an organizational tool and a point of reference for teachers.

The contextual map organizes the module content into:

- content dealing primarily with NATURAL SYSTEMS:
- content dealing primarily with HUMAN SYSTEMS; and,
- content dealing with the INTERACTIONS between these two systems.

These major sectors are drawn as follows:

NATURAL SYSTEMS	INTERACTIONS	HUMAN SYSTEMS

The map further organizes the module content into:

- content dealing primarily with OPERATIONAL aspects (processes, functions, and applications of concepts); and
- content dealing primarily with CONCEPTUAL aspects (emphasizing ideas, theories, principles and laws)

	NATURAL SYSTEMS	INTERACTIONS	HUMAN SYSTEMS	
OPERATIONAL				OPERATIONAL
CONCEPTUAL				CONCEPTUAL

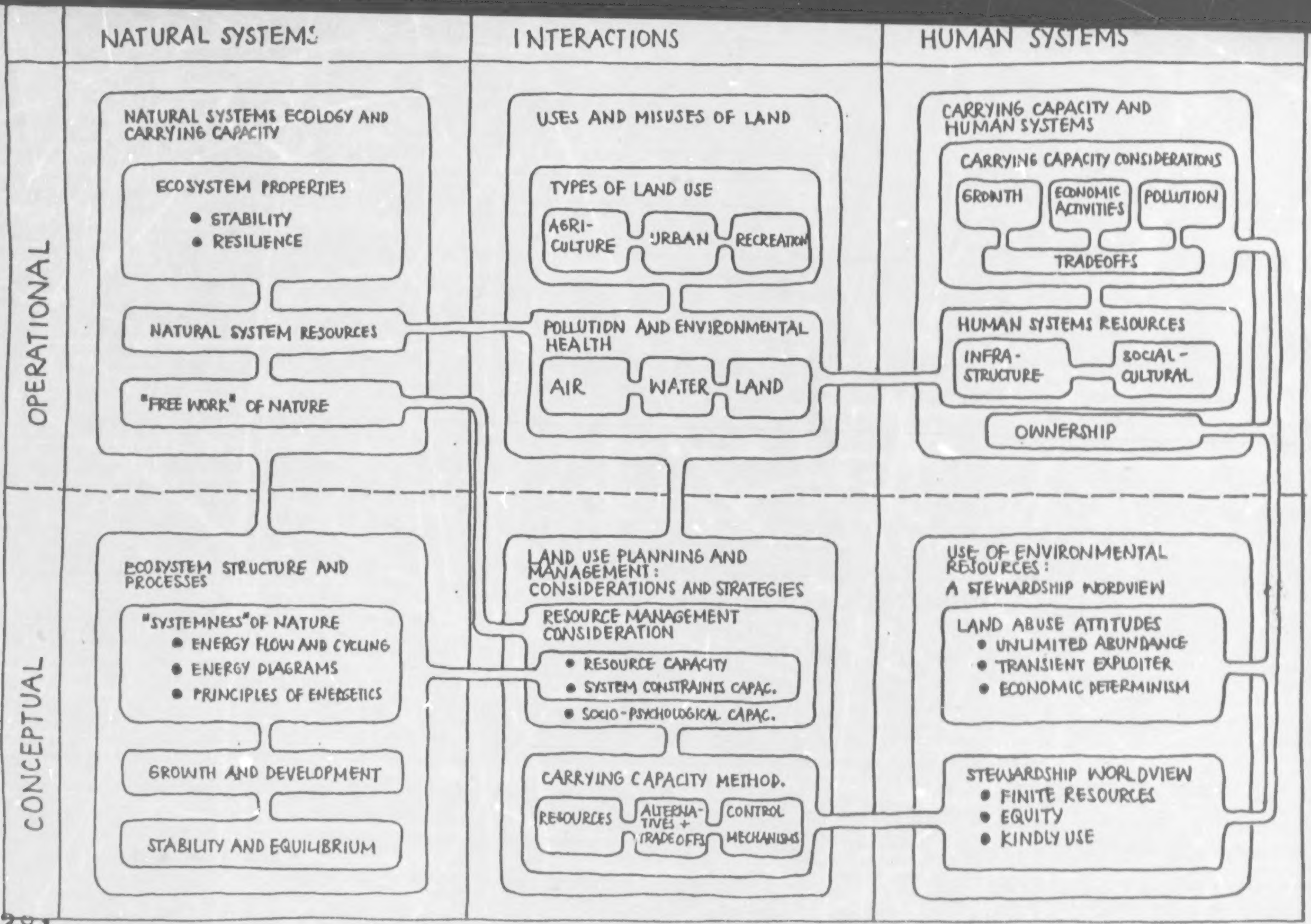
NATURAL SYSTEMS
INTERACTIONS
HUMAN SYSTEMS
OPERATIONAL
CONCEPTUAL
NATURAL SYSTEMS ECOLOGY AND CARRYING CAPACITY
ECOSYSTEM PROPERTIES
• STABILITY
• RESILIENCE
NATURAL SYSTEM RESOURCES
"FREE WORK" OF NATURE
USES AND MISUSES OF LAND
TYPES OF LAND USE
AGRI-CULTURE
URBAN
RECREATION
POLLUTION AND ENVIRONMENTAL HEALTH
AIR
WATER
LAND
CARRYING CAPACITY AND HUMAN SYSTEMS
CARRYING CAPACITY CONSIDERATIONS
GROWTH
ECONOMIC ACTIVITIES
POLLUTION
TRADEOFFS
HUMAN SYSTEMS RESOURCES
INFRA-STRUCTURE
SOCIAL-CULTURAL
OWNERSHIP
ECOSYSTEM STRUCTURE AND PROCESSES
"SYSTEMNESS" OF NATURE
• ENERGY FLOW AND CYCLING
• ENERGY DIAGRAMS
• PRINCIPLES OF ENERGETICS
GROWTH AND DEVELOPMENT
STABILITY AND EQUILIBRIUM
LAND USE PLANNING AND MANAGEMENT: CONSIDERATIONS AND STRATEGIES
RESOURCE MANAGEMENT CONSIDERATION
• RESOURCE CAPACITY
• SYSTEM CONSTRAINTS CAPAC.
• SOCIO-PSYCHOLOGICAL CAPAC.
CARRYING CAPACITY METHOD.
RESOURCES
ALTERNA-TIVES + TRADEOFFS
CONTROL MECHANISMS
USE OF ENVIRONMENTAL RESOURCES: A STEWARDSHIP WORLDVIEW
LAND ABUSE ATTITUDES
• UNLIMITED ABUNDANCE
• TRANSIENT EXPLOITER
• ECONOMIC DETERMINISM
STEWARDSHIP WORLDVIEW
• FINITE RESOURCES
• EQUITY
• KINDLY USE

FIGURE A. CONTEXTUAL MAP - OPTIMAL USE OF FINITE LAND RESOURCES

CONTEXTUAL MAP: OPTIMAL USE OF FINITE LAND RESOURCES

The satisfaction of human needs through the utilization of natural resources is an interactive process. The Contextual Map indicates these connections between natural and human systems.

INTERACTIONS OPERATIONAL: This sector describes the major types of LAND USE in the United States and describes some major types of POLLUTION and LAND ABUSE resulting from human interactions with the land. The overall purpose here is to orient you to humankind's past and present IMPACT on the land. (INQUIRY, Section 1)

HUMAN SYSTEMS CONCEPTUAL: This sector describes some EVENTS, ATTITUDES, and BELIEFS which have contributed to the over-exploitation and misuse of natural resources in the United States. It also presents an image of a STEWARDSHIP WORLDVIEW that is consistent with certain attitudes and values inherent in a protective and conserving approach to nature, land, and resource management. (INQUIRY, Section 2)

NATURAL SYSTSMS CONCEPTUAL: This sector describes the STRUCTURE AND FUNCTIONS of natural systems and cycles on which we depend. It provides a knowledge background for appreciating the value of a stewardship approach to nature and for understanding the CAPACITIES AND FINITE RESOURCE CAPABILITIES of natural ecosystems. (INQUIRY, Section 3)

NATURAL SYSTEMS OPERATIONAL: This sector describes types of NATURAL SYSTEM RESOURCES, the major types of LANDFORMS, and the BENEFITS OR "FREE WORK" derived from these landforms. It also introduces the notion of CARRYING CAPACITY from the perspective of ecosystem properties, resources, and functions. The overall purpose here is to provide an understanding of what natural resources are and what they can "DO"; this will offer a basis for later examining the conflicts between natural and human systems. (INQUIRY, Section 4)

HUMAN SYSTEMS OPERATIONAL: This sector extends the natural systems notion of CARRYING CAPACITY to include human systems. It elaborates upon the various aspects important to understanding the CONFLICTS that arise between humans' demands for resources and desires for quality of life and natural systems' capacities to satisfy these demands and desires. It also examines the INTERRELATIONSHIPS between human systems resource capabilities and natural systems' resources. (INQUIRY, Section 5)

INTERACTIONS CONCEPTUAL: This sector describes some criteria for RESOURCE MANAGEMENT and a general CARRYING CAPACITY METHODOLOGY for land use PLANNING AND DECISION MAKING. It examines various mechanisms for LAND USE CONTROL as well as different APPROACHES to land use planning. (INQUIRY, Section 6)

OBJECTIVE: (x) To list the major topics, concepts, principles and processes associated with an environmental energy problem and display them in a contextual map.

TO DO: 1. Examine the contextual map (Figure A, p.276). Note that the map displays the major topics, concepts, principles, and processes associated with the environmental issue of Optimal Use of Finite Land Resources.

2. Using the general environmental issue of land use, select a specific urban growth problem you could present to your students. Think about this problem in terms of:

   (a) aspects involving natural systems, human systems, and the interactions between the two systems;

   (b) major topics, concepts, principles, and processes associated with these aspects.

3. List at least 20 major topics, concepts, principles, and processes associated with your land use problem. Clarify and display these topics, etc. using the contextual map format below:

NATURAL SYSTEMS	INTERACTIONS	HUMAN SYSTEMS

SECTION 2

CHECKLIST FOR PLANNING ENVIRONMENTAL/ ENERGY-FOCUSED INSTRUCTIONAL UNITS OR LESSONS

After completing this section you should:

(12) Be able to plan instructional activities for your students by applying a set of guideline criteria.

This section presents guideline questions for planning and developing environmental/problem-focused instructional materials and activities.

CHECKLIST FOR PLANNING ENVIRONMENTAL/ENERGY-FOCUSED INSTRUCTIONAL UNITS OR LESSONS

Having completed the preceding design activity, you are now ready to develop a tentative plan for a "land use focused" unit or lesson which is compatible with, but not necessarily limited to your subject area, e.g., Social Sciences, Natural Sciences, Humanities, etc. You can develop this plan by using the checklist which follows.

This checklist consists of a series of questions you should address when planning environmental/ energy-focused instructional activities for your students. Successful completion of these questions will help to ensure your developing an effective and instructionally sound unit or lesson plan.

Since the checklist questions are intended only as a guide for your planning task, you are free to address them in any of the following ways:

- you can plan a problem-focused instructional unit or lesson according to your own interests and planning style, and then refer back to the checklist to ensure that your plan is comprehensive.
- you can plan an instructional unit or lesson by answering the checklist questions directly as listed or in any order you choose.
- You can plan an instructional unit or lesson by utilizing both of these approaches, i.e., alternating between the two as your plan develops.

Whichever of these approaches you intend to use, it is strongly recommended that you begin your planning by considering the problem context of the unit or lesson (addressed in checklist question #1) which will be the basis for your entire plan.[1]

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[1] Prior to making your plan you may also want to read Appendix A, Planning Instructional Unit or Lessons, for a review of some characteristics of classroom instructional materials, and Appendix B, Developing an Instructional Unit or Lesson Following the Module Format.

CHECK COMPLETED
PLANNING AREAS
HERE

a. Have you selected an environmental/energy problem context appropriate for your students?

(1) Have you selected a problem area or issue of national priority or significance? ☐

What is your problem area or issue?

(2) Have you determined the level at which your problem has significance? ☐

- local, county ________
- multi-county, state ________
- multi-state, regional ________
- national ________
- international, global ________

Keep in mind that the most important environmental/energy problems have implications or counterparts at all or many of these levels.

(3) Have you characterized the major focus or emphasis of your unit or lesson? (You may prefer to answer Questions d. and e. before completing your answer here). ☐

- Natural systems functions, processes ____
- Human systems functions, processes ____
- Interactions between natural and human systems ____

Keep in mind that a HOLISTIC and INTEGRATED approach to studying the problem area would involve an examination or exploration of the complex interrelationships between natural and human systems rather than focusing exclusively on either.

(4) Have you characterized the various aspects of the problem area which your students are to investigate? (You may prefer to answer Questions d. and e. before completing your answer here). ☐

- physical ____
- social (includes economic, political, legal, etc.) ____
- aesthetic ____
- ethical ____

Keep in mind that a TRANSDISCIPLINARY approach to studying the problem area would involve an examination and synthesis of information from a variety of aspects, disciplines, or points of view.

b. Have you considered how you will introduce the problem issue to your students; how you will interest and motivate them? ☐

Pep talk ____ Movie ____ Guest Speaker ____

Field trip or site visit ____

Student self-directed activity ____

Other ________________________

c. Have you determined what broad or general questions regarding the problem area you want your students to answer or address? ☐

What are these general questions?

d. Have you identified key topics or sub-topics related to the problem area which your students will cover? ☐

What are these key topics or sub-topics?

e. Have you identified key concepts, principles, and terminology which will be covered? ☐

What are these key concepts, principles, ideas, and terminology?

f. Have you determined whether or not there are special knowledge or skill prerequisites that your students should have in order to study the problem area? ☐

What are these prerequisites?

g. Have you decided what learning activities you are planning to use to convey the relevant topics, concepts, principles, etc. to your students? (Example activities might include: tours, field trips, written assignments, lectures, interviews, experiments, special projects, simulations, discussions, etc.). ☐

What are these activities? (Be as specific as possible.)

(You may prefer to answer Question (1) below before completing your answer here.)

(1) Do any of the activities engage your students in PROBLEM-SOLVING or DECISION-MAKING processes with respect to the problem area? ______

(2) Are the activities ones that your students can:

- relate to in terms of their experiences? ______
- complete in the amount of time available? ______

h. Have you identified available resources which your students will need in studying the problem or issue? (Resources might include: readings, films, interviews, reports, etc.) ☐

What are these resources? (Be as specific as possible.)

i. Have you specified student learning objectives for the unit or lesson? ☐

What are these student learning objectives?

j. Have you determined how you will evaluate whether or not your students have achieved these learning objectives? (Evaluative measures might include: discussion questions, written or oral reports, special task or project assignments, test questions, etc.) ☐

What are these evaluative measures? (Be as specific as possible.)

k. Have you determined an instructional sequence and schedule for your unit or lesson? ☐

Describe the sequence of activities in as much detail as possible, i.e., describe your lesson plan.

EXAMPLE FORMAT:

Day/ week	Topics/sub-topics to be covered	Key concepts, principles, ideas to be covered	Activities to be used to convey the topics & key concepts

OBJECTIVE: (y) To complete a checklist for planning environmental instructional units or lessons

TO DO: 1. Now that you are familiar with the characteristics of a problem context and have read over the guidelines for developing an instructional unit or lesson, you can begin the process of planning your own instructional unit, lesson, or program. Remember that your ultimate planning goals are:

- To engage students in learning activities (readings, discussions, exercises, etc.) which address environmental issues or problems, e.g., OPTIMAL USE OF FINITE LAND RESOURCES.
- To raise students' level of awareness and understanding of the issues or problems to a level as near as possible to your own.

2. Start by filling out each of the CHECKLIST items (pp.) as best you can. Keep in mind that these items are intended to aid you in being as detailed and specific as possible in planning your classroom environmental unit(s) or lesson(s).

3. Feel free to utilize the CHECKLIST in any way you deem helpful. For example, you may decide to: (1) develop an instructional unit or lesson plan on your own, then use the CHECKLIST items to assess the scope and adequacy of your plan; or (2) complete the CHECKLIST first, then reorganize and sequence the information into an instructional plan.

Once you have completed the APPLICATION, you should:

- BE FAMILIAR WITH THE BASIC CHARACTERISTICS OF AN ENVIRONMENTAL/ENERGY PROBLEM OR ISSUE CONTEXT.
- HAVE DEVELOPED A PRELIMINARY PLAN FOR AN ISSUE OR PROBLEM-FOCUSED ENVIRONMENTAL UNIT(S) or LESSON(S) (e.g., OPTIMAL USE OF LAND RESOURCES) which can be implemented in your classroom.

APPENDIX A: PLANNING INSTRUCTIONAL UNITS OR LESSONS

APPENDIX B: DEVELOPING AN INSTRUCTIONAL UNIT OR LESSON FOLLOWING THE MODULE FORMAT

APPENDIX C: INQUIRY ACTIVITY ANSWERS

APPENDICES

PLANNING INSTRUCTIONAL UNITS OR LESSONS

A. DISTINCTION BETWEEN A SINGLE CONCEPT AND A MULTIPLE CONCEPT APPROACH

Question--How does a single concept approach to environmental education differ from a multiple concept approach?

A single concept approach has these characteristics:

- a single concept or skill is treated;
- instructional content is brief, requiring only a few days to complete;
- only a few, highly specific resources are used.

A multiple concept approach has these characteristics:

- several concepts or skills are treated;
- instructional content is longer, containing several concepts, and may take several weeks to complete;
- many resources, both general and specific, are used.

Question--When should you emphasize a single or multiple concept approach?

The single concept approach should be emphasized:

- when you are dealing with a single, discrete idea or topic area--not a cluster of ideas or skills, or a problem area or theme;
- when your intent is to introduce the learner to a set or series of single concepts, ideas, or skills as preparation for presenting a more complex problem context;
- when an understanding of the overall problem area or context is not, for the moment, of primary importance.

The multiple concept approach should be emphasized:

- when you are dealing with a set of environmental concepts, ideas, or skills which are complex;
- when your intent is to involve students in planning or decision-making on a group or team basis;
- when it is important to present an entire problem context, e.g., the natural, social (including political, economic, legal), aesthetic, and ethical aspects of the selected issue as a necessary background to planning and decision-making;
- when in-depth inquiry and value-development are part of the planning and decision-making application.

These criteria are not hard and fast, but they suggest two instructional possibilities: (a) younger students might benefit more from a single concept approach in order to prepare or ready them for involvement in more complex activities; and (b) a multiple concept approach might better serve secondary school students (grades 10-12) and adults. Intermediate level students, grades 7-9, may benefit from a combination of both approaches.

In the APPLICATION, we emphasize the design of instructional unite or lessons which utilize a multiple concept approach in addressing environmental issues of national importance.

B. CHARACTERISTICS OF INSTRUCTIONAL UNITS OR LESSONS

In planning environmental education instructional units or lessons, consider the following self-directing questions. As you address these questions in your initial planning, you should begin to form a general picture of the features or characteristics of your instructional units or lessons.

1. Student factors

THINGS YOU NEED TO KNOW AHEAD OF TIME

- What is your understanding of your students' degree of preparation or readiness for problem-focused, decision-making oriented learning materials and experiences?
- Is the problem area too sophisticated or complex?
- Are the reading resources (such as those presented in the bibliography of this module) too difficult, too sophisticated?
- Would learning exercises or simulation activities (such as those presented in the Inquiry section) be too difficult, too demanding?
- Would your students be able to work effectively within a group or team learning mode? Will it be necessary to utilize a more individualized learning approach? Some combination of group and individualized learning?

If you are uncertain as to your students' readiness or motivation for these activities, you may wish to assess their preparation with some preliminary learning activities involving:

WAYS YOU CAN FIND OUT

- sample readings addressing the problem context with follow-up class discussions (these may focus on single concepts or single subtopics as expedient);
- small group assignments to explore some specific community resources related to the problem context (e.g., tours, site visits, talks with knowledgeable persons, etc.);
- simplified problem-solving, decision-making, or values clarification exercises focusing on some sub-aspect of the problem issue.

Remember that in assessing your students' readiness, it is not so important to determine how much they know about the problem issue as it is to determine if they will be able to: (a) complete reading and resource exploration assignments, (b) interact and exchange ideas effectively in large or small groups, and (c) utilize problem-solving and decision-making processes required in the learning activities (exercises, simulations, etc.).

2. Teacher factors

- Do you see yourself only, you and another teacher, another teacher only, or a larger teacher team using the instructional materials?
- How much direction, guidelines, or preparatory training will this person or persons require?

WHO WILL
USE THE
MATERIALS

If you see yourself as the prime or sole user of the instructional materials, you will still need to specify the details of an instructional plan. The specific learning activities and the schedule of events should be specified.

If you are devising the instructional materials for other persons, then very detailed usage steps, timetables, and resource materials will need to be provided in addition to the above.

And with team-devised/team-taught materials, it is suggested that a set of directions be provided so that one person can serve as a team monitor to keep track of instructional variations, new ideas, and changes in procedures, and to monitor and record the entire set of activities.

3. Instructional factors

- What should go into the instructional plans for developing the environmental education units or lessons?

Here are a minimum number of things to consider:

a. Instructional aims--the overall educational reasons or benefits for using the materials.

b. Learning objectives--the general and specific knowledge and skill development objectives, stated in behavioral terms, that is, in terms which are measurable and observable and which specify criteria against which successful performance can be assessed. With student-training materials, the learning objectives should be keyed directly to the steps of the instructional sequence.

c. Resource requirements--the required and optional learning resources for developing students' knowledge and skills. The resources might include films, slides, and other A-V materials, maps, charts, case studies, bibliographies, monographs, periodicals, newspapers, magazine articles, textbooks, paperbacks, tours, lectures, T.V. and radio programs, site visits, agency/organization publications, interviews, field studies, learning games, simulations. These resources can be teacher-prepared, student-devised, or commercially perpared.

d. Learning arrangements--as a rule, student learning arrangements should vary or change during the instructional sequence of units or lessons. Thus, students move through a series of large group, small group, and individual study/discussion/application tasks as required by the instructional sequence. This practice offers the student not merely a "change of pace," but opportunities for escaping either psychologically or physically from the confines of standard classroom pedagogy.

e. Timetables, schedules--multiple-concept, problem-focused instructional units, especially when preceded by shorter, single-concept preparation units, may take several weeks to complete. It is important that time allocations, sequences, and schedules for instructional/learning activities be specified.

f. Information handling and evaluation--within a given unit or lesson, there are a number of useful student evaluation checks which can be built into each step of the instructional sequence, e.g., student reports, discussion worksheets, inquiry and application task checklists, and other evaluative materials. It is necessary, therefore, to indicate the procedures to be used and the forms to be collected at the end of each step. It is also necessary to key the evaluation to the student learning objectives.

g. Options and special activities--there can be many resources and activity options at each step of an instructional sequence. This flexibility should be utilized by teachers to ensure that the learning activities are compatible with the needs, interests, and abilities of students. Therefore, if desired, optional or special learning resources (and activities) can be used.

4. Instructional sequence

- What general steps or tasks need to be specified for an instructional unit or lesson which develops students' knowledge and skills in a selected environmental problem issue?

The instructional sequence or steps can follow any one of a number of formats depending on the intended users. The general format utilized in the present instructional module and a student-oriented variation of it are presented in Table One only as examples:

TABLE ONE

The teacher training module instructional sequence	A possible student lesson instructional sequence
● INQUIRY Knowledge development (utilize problem-relevant resource materials) ● INTEGRATION Skill development (utilize problem-focused exercises, simulations) ● APPLICATION Student learning unit/lesson design and development	● INQUIRY Knowledge development (utilize problem-relevant resource materials ● INTEGRATION Skill development (utilize problem context-focused exercises, simulations) ● APPLICATION?

30[illegible]

5. Problem context

- What tasks are necessary to develop the environmental problem context described in Section 1 of the APPLICATION?

In order to develop this problem context to a level which is presentable to students, you will need to do the following:

a. Identify a problem issue which has both national significance and significance at regional, state, or local levels.

b. Select (or develop if necessary) a regional, state, or local level scenario as a frame of reference for studying the problem issue--whichever level is of greater interest or significance to learners.

c. Identify available resources (readings, tours, lectures, films, interviews, etc.) for studying the problem issue at the level (or levels) selected.

When properly developed, the problem context will constitute an effective and comprehensive basis for exploring the environmental problem issue through case studies, simulations, and other learning activities.

DEVELOPING AN INSTRUCTIONAL UNIT OR LESSON FOLLOWING THE MODULE FORMAT

The student instructional sequence presented in Appendix A, Table One will now be utilized to present some basic tasks necessary for developing an environmental/energy-focused instructional unit or lesson similar in format to the one utilized in this teacher-training module. These tasks, when fully elaborated and geared to the students' level of sophistication, can take the form of a user-ready set of student learning materials or a set of instructional guidelines for making topic presentations, problem-focused classroom discussions, student work assignments and skill development exercises, and evaluating students' performance and progress.

Keep in mind that this is an example of only one possible instructional unit or lesson format for your students. If you wish to utilize another format, proceed according to the guideline questions of Section 2 of the APPLICATION.

STEP ONE: INQUIRY--Develops students' knowledge base regarding the selected environmental problem issue by involving them in an in-depth exploration of the problem using relevant learning resources.

1. Describe the environmental problem or issue for the unit or lesson. Tell students why this problem is significant both nationally, locally, regionally, or globally as the case may be. Tell them why you have selected this problem area from other possible ones.

2. Describe the instructional sequence for the unit or lesson, the instructional strategies you will use, and the learning arrangements they will use. Explain the general learning (knowledge and skill) objectives, the general time-line or schedule of events, the resource requirements, and the criteria and methods by which they will be evaluated (or will evaluate themselves).

3. Define all terms which students don't understand.

4. Define or describe the essential questions which must be answered regarding the problem (or have the students do this if they select the problem area). Make certain the problem issue has been adequately specified by defining or describing relevant data resources, concepts, principles, and activities related to the problem area.

5. Organize the resources in several ways to diversify students' possible entries into the knowledge base: (a) organize them according to natural systems, human systems, or the interactions between the two; (b) organize them according to topics (key environmental entities) or process (content/processes) you wish to emphasize; (c) organize them according to the various physical, social (including economic, political, legal), aesthetic, and ethical aspects of the environmental/energy problem issue.

   Teachers can begin the process of selecting and organizing student learning resources by asking themselves (a) which of the topics, sub-topics associated with the subject area, and (b) which learning resources are relevant to both the problem area and to my own subject area.

6. Develop a list of study/discussion questions to guide students in their exploration of the learning resources. Key these questions to the major features or critical points of the environmental/energy problem issue covered by the resources. Use these questions in written assignments or follow-up discussions to assess students' depth of understanding.

STEP TWO: INTEGRATION-- Develops students' skills in applying their knowledge of the environmental problem issue by involving them in policy planning and decision-making activities.

For example, a simulation activity would require you to:

1. Select or prepare a general scenario which describes the environmental problem in a specific setting (local, regional, national, global).

2. Prepare a set of descriptions or guidelines for the students to act as planners, policy-makers, and decision-makers in addressing the problem issue presented in the scenario. Organize students into groups or subcommittees and assign each to explore a different major aspect of the problem in more depth.

3. In order to heighten students' interest in the activity, you may wish to enhance the problem scenario by preparing a set of descriptions or representative articles or documents (e.g., letters of concern) which present the viewpoints and concerns of individuals and groups who might reasonably be affected by or interested in the problem issue. It may be useful to key these concerns to the major physical, social, aesthetic, and ethical aspects of the problem context.

4. Select or prepare a set of data or facts which cover the energy aspects of the problem scenario and which the students can use in their planning, problem-solving, or decision-making task. Prepare any additional information, maps, charts, illustration, etc., which the students may need.

5. Develop a general time-table or schedule for how long each task of the simulation is to last and the order in which tasks are to be carried out.

6. Define all terms and concepts which students don't understand. Clarify any misunderstanding regarding the major aspects of the problem issue, use of resources, or simulation procedures. Hold a post-simulation debriefing with students to summarize their findings, conclusions, and recommendations.

STEP THREE: EVALUATION--Evaluation items may be developed for each step or for the entire unit or lesson.

- INQUIRY evaluation should assess students' overall understanding of the key dimensions or critical aspects of the environmental problem context.

> Key question--Have students acquired the requisite knowledge and level of understanding of the environmental problem?

- INTEGRATION evaluation should assess students' general performance in developing coherent positions or in formulating justifiable policy statements regarding the problem issue.

> Key question--Are students able to utilize their knowledge and understanding in a problem-solving or decision-making task?

Keep in mind that evaluation measures may take one or several of the following forms:

Think/discussion questions

Written and oral reports

Performance assessment of activities, tasks, or special project assignments

Test questions

Appendix C provides example answers to each of the Activities in the INQUIRY. Many of these answers have been devised by teachers and are offered as a basis for comparison only.

INQUIRY ACTIVITY ANSWERS

SECTION 1

ACTIVITY I: See Chart 1 for example answers.

ACTIVITY II: See Chart 2 for example answers.

SECTION 2

ACTIVITY I: The attitudes reflected in the two expressions imply a willingness or receptivity to continual growth and expansion (of population, technology, etc.) which have traditionally required greater and greater exploitation of the natural environment and its resources.

ACTIVITY II, Reading I:

1. See Chart 3 for example answers.
2. Their intent is to protect and preserve our resources and world, not use them; they have no idea about engaging in a "living relationship" with the land; they are concerned with recreational goals and environmental disasters and often see humankind apart from the land rather than working with it.
3. We need places to go to restore the memory of our biological and cultural roots--in nature. We need the experience of leaving something alone, allowing certain places to influence rather than the opposite. We need a model in wilderness so we can see how it was and be able to tell how it is.

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*These answers have, on the whole, been supplied by teachers and are considered reasonable or adequate.

Chart 1

Type of Land Use	Approximate % of Total Land Use	Major Inputs (Natural & Human Resources Required)	Major Outputs (Products: Goods Services)	Current Use or Misuse Problems	Possible or Probable Future Trends
Agricultural	25%	Soil, climate, labor, services fertilizer, tools	Food, raw materials	Pollution of: land, water, air, pesticides	% of agricultural land has decreased, high yield crops; genetic restriction; decreased human labor; increased urbanization
Grazing (Livestock Production)	34%	Soil, climate, feed, labor, medical care	Food, raw materials (leather)	Pesticides in food, hormones, pollution of streams, over grazing	Increased population leads to increased demand. Public and private use of grazing land (P+R)
Forest and Woodland	32%	Soil, climate, labor, tools	Raw materials	Deforestation; destruction of water shed; loss of natural habitat erosion; destruction of ecosystem	Increased demand for lumber; decreased quality of materials, improved management
Urban	1%	Land, climate, raw materials, labor, food, transportation, government, sewage, power	Employment, culture, education, manufactured goods interdependence	Pollution, urban sprawl, crime, poverty, overcrowding	Urban renewal; social problems: less defined neighborhoods and city limits
Recreation	2%	Land, climate, labor, money from taxes	Recreation	Shrinking space-time relationships, increased population; increased demand, over use	Increasing use and concern for natural environment; multiple uses of land areas; big business investments; increased management and maintenance costs
Miscellaneous:	8%				
• Water Storage and Management		Climate, topology, labor, management, building materials	Water, power Recreation Urban services Agriculture	Shortage; disruption of ecosystem; pollution; loss of agricultural land; silting; poor management	Continued Water shortage New sources (desalinization); Improved management increasing cost

Chart 1 (cont'd.)

Type of Land Use	Approximate % of Total Land Use	Major Inputs (Natural & Human Resources Required)	Major Outputs (Products: Goods Services	Current Use or Misuse Problems	Possible or Probable Future Trends
• Transportation		Land, labor machinery, goods, engineering	Communication, Decreased space-time ratio	Poor planning, pollution, urbanization, lack of public control, relocation of homes, increased fuel use	Improved Mass Transit, strong Pollution Controls, increased Cost and fuel, increased taxes
• Mining		Land, labor, management, machinery, engineering	Goods, services, raw materials, fuel	Pollution, land destruction erosion	Decreased availability, alternative sources, reclamation, recycling, new techniques

Chart 2

SOURCES OF POLLUTION	PROPOSALS TO REDUCE OR PREVENT POLLUTION	RATINGS
I. Air Pollution (in decreasing order of contribution)		
Transportation	Technology Pollution Control & Mass Transit	2
Electrical power generation	Pollution controls Technology (Alternative energy) Conservation	2
Industry	Strict Regulation; Educational Tax Incentives	2
Refuse disposal	Recycling; Educational Research Conversion to power; Tax Incentives	3
Other - Forest and Agricultural Fires	Controlled burning regulation; Preventative measures; Research; Policy Issues defined	2
II. Water (in decreasing order of contribution)		
Industry	Education; Better siting; regulations; Tax incentives/fines--proper disposal systems	2
Agriculture	Regulations; Chemical controls; Zoning; Tax incentives	1
Household (domestic waste)	Education; Zoning; Taxes; Building Restrictions; Population Control	2
Mining	Regulations; Technology	2
Construction	Zoning Restrictions; Growth limitation	3

Chart 2 (cont'd.)

III. Land (in decreasing order or contribution)

Solid waste	Recycle; power conversion	3
Urban Sprawl	Zoning; Growth limitations	2
Surface Mining	Regulations; Reclamation	2
Deforestation	Planning; Education; Selective cutting; Reseeding	3
Chemical	Regulation Alternative Methods	2
Radiation	Technology	

Chart 3

Model Exploiter	Model Nurturer
Example: Strip miner--a specialist/expert	Example: Old fashioned farmer--a non-specialist
Standard money, profit, efficiency	Standard care, health for all
Land attitude How much can it be made to produce and how quickly?	Land attitude What is the carrying capacity? How much can be taken without diminishing it? What can it produce dependably for an indefinite time?
Work attitude Earn as much as possible with least work.	Work attitude Work as well as possible and make decent living.
Competence is in organization.	Competence is in order.
Serves an institution or organization	Serves land, household and community.
Thinks in terms of numbers, quantities, hard facts.	Thinks in terms of character, condition, quality, kind.

SECTION 2 (cont'd.)

ACTIVITY II, Reading II:

1.a.
- Allow "rights" under law to natural objects themselves, not only as they are represented by humans whose rights are threatened.
- Provide for guardianship for both public natural objects and private land. A guardian would be given rights of inspection and rights to seek redress. This approach would secure an effective voice for the environment.
- Establish realistic damages in terms of environmental cost and allow natural objects to be "beneficiaries" of awards.

b. Aesthetic improvements may "cost" us, i.e., reduce our standard of living as measured in terms of our present values. Those who have certain material comforts may have to forfeit them while others may need to abandon the hope of acquiring them. We need to take into account depleting energy and food supplies and curtail growth, including population growth. Some benefits would be the re-definition of goals and needs in terms of an "environmental consciousness," learning again how to live with nature, discovering the interrelatedness of all life processes, planning for the long-term future, enlarging our scope of consideration to "spaceship earth."

2.a. A resource use ethic would be established, monitored by "guardians" and upheld by the courts. Abused resources would be restored.

b. Curtailing energy resource exploitation and depletion would mean implementing a conservation ethic in both individual and aggregate lifestyle practices.

c. Individuals would act as guardians to resources, would be bound by law to respect rights of natural objects.

d. Equal rights for the systems of humanity and the systems of nature--right to redress of grievances and monetary compensation. Equalized access by societal sectors to resources and resource products.

SECTION 2 (cont'd.)

ACTIVITY II, Reading III:

Your discussion should reveal that a "man in nature" orientation emphasizes humankind's understanding and cooperation with nature's processes, its intelligent and conserving use of natural resources, and its appreciation of their own as well as nature's mutual interdependence and right to survive in the long run without being degraded. In contrast, a "man versus nature" orientation emphasizes humankind's subjugation and exploitation of nature to its own ends, its intensified and excessive use of natural resources, its uncontrolled production of wastes and pollution, and its ignorance or lack of appreciation and regard for natural processes and cycles.

ACTIVITY III: SUMMARY

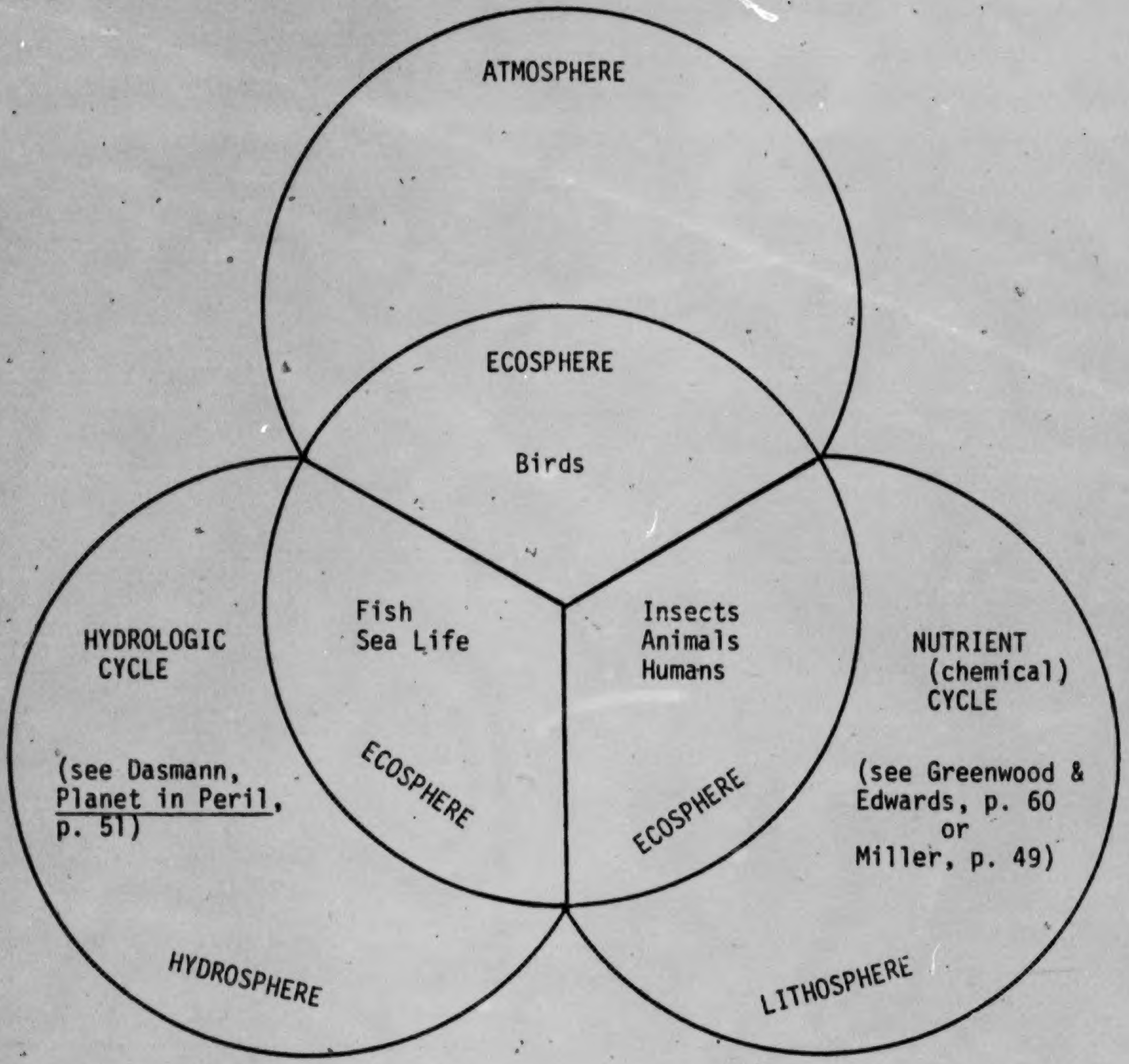
- A limited amount of energy and natural resources.
- Equal access to and fair distribution of resources and products.
- Caring for (conserving) limited resources; using skills to achieve quality of life.
- To use something in a manner that preserves it (allows it to be regenerated or replaced).
- Use of simple or power-efficient tools; more labor-intensive work instead of energy-intensive.
- Personal decision-making with respect to resource use; role as a guardian of resources; participation needed to check and balance institutional power.
- We create the future; present decisions should reflect long-term goals and quality of life for future generations.
- Centralization costs more energy to operate and is removed from the local resource base and individual consumers/decision-makers; more vulnerable to terrorist or single disaster shut down.

SECTION 3

ACTIVITY I:

This activity requires that you draw out or chart what you know about the major systems of our biosphere based on your review and summarization of the information presented in the specified readings (or any others you find useful).

The diagram which follows offers an incomplete example of what a drawing might look like.


ATMOSPHERE
ECOSPHERE
Birds
Fish
Sea Life
Insects
Animals
Humans
HYDROLOGIC CYCLE
(see Dasmann, Planet in Peril, p. 51)
NUTRIENT (chemical) CYCLE
(see Greenwood & Edwards, p. 60 or Miller, p. 49)
ECOSPHERE
ECOSPHERE
HYDROSPHERE
LITHOSPHERE

EXAMPLE:

The HYDROLOGIC CYCLE links the other two systems in terms of condensation and precipitation (atmosphere), surface runoff, sub-surface water (lithosphere), and evaporation and transpiration (lithosphere-atmosphere).

ECOSYSTEMS form the central link between the 3 major systems since all life depends to varying degrees on a combination of air, water, and chemical nutrients.

SECTION 3 (cont'd.)

ACTIVITY II:

1. Dairy (milk production) System

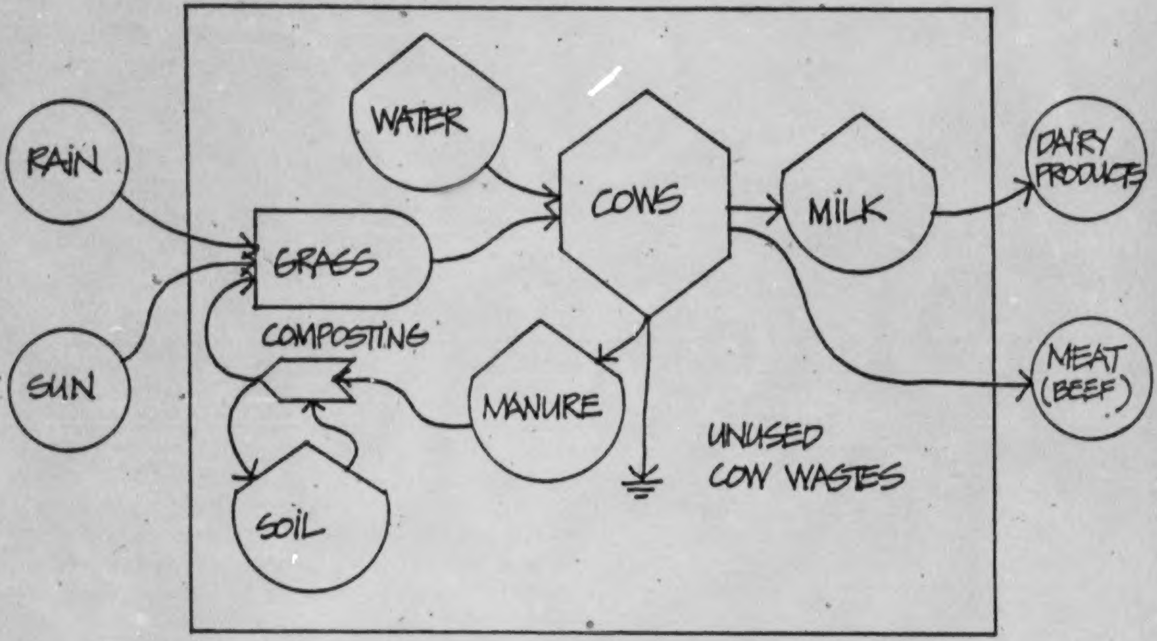
2 and 3. See Below

INPUTS	STORAGES	CONSUMERS	PRODUCERS*	OUTPUTS
• rain • sun	• milk • fertilizer (cow wastes) • soil • water	• cows	• grass *production involving photo-synthesis	• dairy products (milk, butter, etc.) • meat (beef) • cow wastes

SECTION 3 (cont'd.)

ACTIVITY II (cont'd.)

4.


RAIN
SUN
WATER
GRASS
COMPOSTING
SOIL
COWS
MANURE
MILK
DAIRY PRODUCTS
MEAT (BEEF)
UNUSED COW WASTES

ACTIVITY III:

1. photosynthesis: sunlight (input)→oxygen (output; ↓radiated heat (energy loss)

food production: sunlight, water, seeds (inputs)→ wheat, corn, etc. (outputs); ↓ heat, wastes (energy losses)

or

agricultural produce, oil, machinery, labor (inputs)→bread, canned foods, etc. (outputs); ↓heat, wastes (energy losses)

automobile operation: gasoline, oil→mechanical motion/ work; ↓exhaust heat

electric blender: electricity→mechanical motion; ↓heat

SECTION 3 (cont'd.)

ACTIVITY III (cont'd.)

2. All the above processes tend towards disorder and loss of energy. Order can be maintained only when there is a large amount of potential energy remaining in the system and/or more energy coming into the system.

3. A farm system depends on the sun and rain for crop production and on the storage and re-use of wastes (manure, plant detritus, seeds) to fertilize and maintain crop growth.

ACTIVITY IV:

A forest develops from grasslands gradually being replaced by scrub, then by chapparel, then by hardwood trees (succession). Smaller trees grow by capturing and consuming more and more energy (sunlight, water) until they reach a point where they cannot capture any more (climax) and therefore tend to maintain their structure (stability). A greater variety of trees at different stages of development (diversity) ensures staying power and adaptability of the forest to change and resistence to adverse conditions--disease, insects, lack of rain, etc., (stability). The more favorable the conditions (abundant nutrients, lack of pests and hazards, etc.) the greater the size, luxuriance, and variety of the forest, and vice-versa (feedback).

SECTION 4

ACTIVITY I:

1. Compare your definitions with those presented on pp.   in the text.

2. Example: Lake with vacation homes' septic systems emptying into it.

   The lake has a limited size and capacity to store fresh (rain) water, and to accommodate the rate that sewage is pumped into it (CONSTRAINTS).

   There is a maximum point wherein the rate of sewage input will exceed the lake's ability to produce clear, good tasting, or drinkable water and to provide a "safe" habitat for fish (RIGIDITY).

   The lake can accommodate a certain number of homes and sewage dumping without undergoing noticeable changes (ELASTICITY).

   The lake's ability to continue to maintain its attractive appearance, its water drinkability, and to accommodate sewage depends on the amount of rain it gets, its storage capacity, the amount of evaporation and water use by vacationers, the number of fish and organisms which can eat or break down the sewage, etc. (RESILIENCE).

   When the rate of sewage dumping exceeds the lake's ability (through the above factors) to accommodate it, the lake will begin to suffer pollution damage and to break down as a viable, life-sustaining water system (STABILITY). Whether or not this damage is reversible depends on how long and to what degree it has been allowed to develop.

ACTIVITY II:

1. See Chart 4 for example answers.

2. See Chart 5 for example answers.

ACTIVITY III: See Chart 6 for example answers.

Chart 4

	Renewable	Non Renewable
1. Ambient resources -		
Air, water, open space	X	
Quiet and noise zones		
Sunlight exposure		
2. Spatial resources -		
Underground space		X
Available and Transitional space		
Airways space		
3. Ecological resources -		
Green plants	X	
Non-green plants		
Animals		
4. Economic resources -		
Raw materials (oil, iron, zinc, copper) for production inputs	X	X
Capital, labor		
5. Amenity resources -		
Seashores, scenic areas		X
Contiguous natural areas (mountains, deserts, lakes)		
Open space		

Chart 5

SPECIFIC RESOURCES	GOOD OUTCOMES	BAD OUTCOMES
Coal	Chemicals Dyes Heat Industrial uses Jobs	pollutants lung disease destruction from strip mining
Trees	Lumber Shade Habitat beauty Oxygen Paper products Soil nutrients Erosion controls Jobs (e.g., lumber industry)	Erosion Unsightly clear cut areas Air pollution from paper mills Loss of wildlife habitats
River	Food (fish) Water (for drinking, agriculture, etc.) Habitat for fish Transportation Recreation Minerals to sea Aesthetic value Jobs Electric power Flood control	Pollution Loss of food Loss of fish habitat Upset food chain Destruction of watershed due to damming

Chart 6

LAND FORM	VALUE 1-7	WORK
Surface Water	(2)(1)	Water storage Climatic amelioration Drought control
Marshes	(1)(2)	Climatic amelioration Recycling of wastes
Flood Plains	(4)	Drought control
Aquifer Recharge	(3)	Water storage and purification
Aquifer	(3)	Source of fresh well water
Steep Slope	(5)	Recreation
Forest Woodlands	(6)	Forest and wildlife habitats/shelters Climatic amelioration
Flat Land (not prime agriculture)	(7)	Small game Rodent habitats

SECTION 5

ACTIVITY I:

- Congestion, wastes, socially determined aspects
- EXAMPLE: Yosemite National Park, California.

Congestion -- high concentration of visitors (e.g., campers, hikers, conventions) every year causes excessive use of the natural resources there.

Wastes -- pollution and waste disposal problems caused by heavy car traffic and campers; air and water pollution, litter, tree damage, etc.

Socially determined aspects -- some friction being generated over concern to preserve natural beauty of park by restricting its use and accommodating peoples' recreation needs; some disagreements over what constitutes pollution and environmental degradation when human use is involved, and what degree of either or both will be allowed are bound to occur.

ACTIVITY II: see Chart 7 for example answer.

ACTIVITY III: see Chart 8 for completed answer chart.

Chart 7

TRADEOFF POINTS

EXAMPLE PROBLEM	PRODUCTION/ CONSUMPTION QUALITY OF LIFE	RESOURCE CAPACITY OF NATURAL ENVIRONMENT	RESOLUTION
Developing the Mineral King Area (Sierra Nevada mountains, California)	. Recreation/ Entertainment . Access to scenic wilderness area . Tourist trade businesses . Provide jobs	. Congestion . Pollution . Solid waste disposal . Fire and safety hazards . Urbanization - freeway to recreation site, lodges, vacation homes, etc.	. Limit development and use . Enforced recycling . Fire prevention training; improved practices and equipment . Zoning to prohibit overbuilding while providing recreational services (gas, food) camping areas, ski lifts, etc.

Class / Resource	System			Renewability		Ownership			
	Natural	Human		Renewable	Non-Renewable	Private Control	Public Control		
		Infra-structure	Social-cultural				Local	Regional	National
• Ambient	X			X			X	X	X
• Spatial	X				X	X	X	X	X
• Ecological	X			X		X	X	X	X
• Economic	X	X	X	X	X	X			
• Amenity	X		X		X		X	X	X
• Infra-structure-Distributive		X		X		X	X	X	
• Social-Cultural		X	X	X		X	X		

SECTION 6

ACTIVITY I:

1. See Chart 9 for example answers; also review pp. 153-157 in text.

2. - Your own value judgment is required here. However, the definition which comes closest to capturing the notion of carrying capacity in terms of the resource, system constraint, and social/psychological aspects will be the most comprehensive.

   - Support of production processes; supply of essential goods and services; efficient distribution and delivery of materials, goods, and services; and assimilation of wastes.

   - See (1) - (6) under c. on p. 160 in the text.

   EXAMPLES:

   (a) driving forces -- government plans to locate and develop more state parks.

   (b) existing resources -- amount of undeveloped scenic wilderness area available; number of natural interest areas off the beaten track.

   (c) possible resource changes -- increasing employment for developers and recreational businesses; increased economic activity due to greater travel (tourism) all over the country; greater air pollution (cars) and litter (campers) problems.

   (d) alternatives -- site fewer parks; restrict use of parks and months allowed for visiting.

   (e) tradeoffs -- policy restricting visitation is judged to offer the best avenue for satisfying peoples' access and recreational needs, while maintaining desired levels of environmental quality.

SECTION 6 (cont'd.)

ACTIVITY I (cont'd.)

(f) implementation -- establishment of a tax base for purchase and for development of land; designation or acquisition of land at desired sites.

3. These comparison and synthesis activities are for the purposes of review and summary and do not have any correct answers.

ACTIVITY II:

- The first part of this activity -- comparing and synthesizing a variety of carrying capacity steps -- is intended for review and summary purposes and as such does not have any correct answer.
- Your response to the second part of this activity will depend on (a) your understanding of the situations involved in McHarg's two land use plans, and (b) your own judgment as to the most effective CONTROL MECHANISM(S) to implement each of the plans.

Chart 9

Characteristics / Type of Capacities	EMPHASIS	MAJOR QUESTIONS	MANAGEMENT OBJECTIVES
Resource	Elasticity and Resilience	How much resource use can be sustained for an indefinite amount of time without altering or degrading the resources?	To achieve maximum sustained yield for a given activity.
	Important Factors -- Ability of the resource to produce a service and ability of the biota/flow systems to recover. (Example: air pollution)		
System Constraint	Physical limits of resources or resource processing.	How much of the nonrenewable resources are being developed and used? At what rate can these resources be converted for end use?	Efficiency in resource use and operation of resource processing systems.
	Important Factor -- Resources may be limited by the ability of the present system to transform and use them. (Example: Difficulty of extracting oil from shale)		
Social/ Psychological	Political/institutional Physical/biological Social/cultural Examines level of satisfaction experienced by users - resource management practices.	How many people, vehicles, etc., can be handled in an activity at one time before the quality of the experience is lost?	Maximize total user satisfaction by allocating resources on the basis of their appropriateness in providing for desired activities.
	Important Factor -- Activities compete for the same resources - management decision.		

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